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THE
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Vol. III.

MARCH, 1922

No. 2

The Captain Scott Memorial Medal.

At a meeting of the members of the staff of the herbarium attached to the Royal Botanic Gardens, Kew, at which Mr. N. E. Brown, A.L.S., formerly a member of that staff, was invited to be present, the Director, in his capacity as an Honorary Member of the South African Biological Society, made the formal presentation, on behalf of the Council of the Society, of the Senior Captain Scott Memorial Medal awarded to Mr. Brown for his contributions to the botany of South Africa.

Addressing the members of the staff the Director said:—

“ I have asked you to meet in order to assist me in carrying out a pleasant duty entrusted to me by the Council of the Biological Society of South Africa.

“ When it became known that Captain Scott and several members of his Expedition had perished in their effort to reach the South Pole, funds were collected towards the erection of a memorial to the leader of the party.

“ Under the auspices of the Transvaal Biological Society a sum of money was contributed by residents of Pretoria. When the Chairman of the general fund—the Lord Mayor of London—was advised of this fact, he informed the Society that the

funds already collected were adequate and suggested that the sum subscribed at Pretoria be used for the erection of a local memorial.

“With the permission of the contributors the Council of the Society resolved to devote the interest of their fund to the provision of two annual Memorial Medals—a Junior, awarded yearly to a South African student for academic distinction in one of the Natural Sciences; and a Senior, granted annually to a member of the South African Biological Society recommended by the Council for scientific merit and special services to the Society.

“The Council of the Society inform me that the Senior Medallists so far have been:—

(1). Sir Arnold Theiler, K.C.M.G.

(2). Dr. I. B. Pole Evans, C.M.G.

(3) Claude Fuller, Assist. Chief, Division of Entomology.

(4). Dr. Ethel M. Doidge, M.A., D.Sc., F.L.S.”

Turning to the recipient of the Medal the Director continued:—

“Mr. Brown,—

“The Council of the Biological Society of South Africa has decided unanimously to award to you this year the Senior Capt. Scott Memorial Medal in recognition of your contributions to the botany of South Africa and have requested me to make the presentation to you on their behalf.

“Your interest in South African plants is now of long standing as in 1885 you dealt with the terrestrial orchids of South Africa in a series of contributions to the *Gardeners' Chronicle*. Five years later you earned the gratitude of South African botanists by your account of the *Stapelieæ Barklyanæ*, published vol. xx of the *Icones Plantarum*. You have taken a share with other members of the Kew staff in the preparation of the *Flora Capensis* since this was resumed under the able editorship of Sir W. T. Thiselton-Dyer, and you have provided accounts, in whole or in part, of fourteen of the natural families dealt with in that work. Your contributions include the elaboration of the *Asclepiadaceæ* and of the genus *Euphorbia*, so that we

can appreciate the gratitude felt by South African botanists for what you have done to assist them.

“ But these services, great as they have been, represent but a part of the assistance it has been your privilege to render to South African botanists. The Editor of the *Flora Capensis* has entrusted to you since the work was resumed the revision of the geographical data relative to every species included in that work. All who have been privileged to help the Editor in assisting our South African colleagues, appreciate the critical acumen and balanced judgment with which you have fulfilled your difficult task and feel that the decision of the South African Biological Society to award to you the medal it is now my pleasant duty to place in your hands is a singularly happy one.”

In acknowledging the award Mr. Brown asked the Director to have the kindness to convey on his behalf to the Council of the Society his deep sense of the honour conferred upon him and to express his grateful thanks for the medal, which he valued the more because he felt it to be in reality an honour done to him less as an individual than as a representative of the staff of the herbarium at Kew. All that he had been able to do on behalf of South African botany had been done as a member of that staff, and his had been but the share allotted to him as one of that staff of the work which Kew had at all times been glad and still would be glad to do on behalf of South Africa.

LIST OF VARIOUS WRITINGS OF N. E. BROWN:—

Monographs of South African orders in *Flora Capensis* Vacciniaceæ, Ericaceæ (excluding *Erica*), Asclepiadaceæ, Labiataæ, tribe Ocimoideæ in part, Euphorbia, Urticaceæ, Ulmaceæ, Pontederiaceæ, Xyridæ, Flagellariæ, Typhaceæ, Aroideæ, Lemnaceæ, Eriocaulæ, Restiaceæ (a few odd sp.).

Monographs of Tropical African orders in *Flora of Tropical Africa*. Asclepiadaceæ, Gentianaceæ (a small part), Euphorbia, Orchideæ (*Disa*), Pontederiaceæ, Xyridæ, Rapaleaceæ, Flagellariæ, Typhaceæ, Aroideæ, Lemnaceæ, Eriocaulæ, Restiaceæ, Mayaceæ.

- Monograph of the genus *Sansevieria*, in Kew Bull. 1915, p. 185, 260.
- Terrestrial Orchids of South Africa, Gard. Chron. 1885, v. 24, p. 135, 231, 307, 331, and 402.
- Stapelieæ Barklyanæ*, Hooker, Icon. Plant, v. 20, t. 1901-1925.
- Botany of the Pilcomayo Expedition, in Trans. Bot. Soc. Edinburgh, v. 20, p. 44-78 (1894).
- Report of the Botanical Collections from Roraima, in Trans. Linn. Soc. ser. 2, v. 6, p. 18-58 and 66-76 (1901).
- List of plants collected in Ngamiland and the northern part of the Kalahari Desert, Kew Bull. 1909, p. 89.
- The *Stapelieæ* of Thunberg's Herbarium, in Journ. Linn. Soc. v. 17, p. 162.
- On certain plants yielding Paraguay Tea, Kew Bull. 1892, p. 133.
- Index Flora Sinensis (Orders Commelinaceæ, Pontederiaceæ, Philodendraceæ, Xyridaceæ, Flagellariaceæ, Juncaceæ, Typhaceæ, Aroideæ), in Journ. Linn. Soc., vol. 36, p. 147-173.
- Variation in *Haworthias*, Gard. Chron. 1878, v. 9, p. 820.
- Caralluma campanulata* and a Revision of the genus, Gard. Chron. 1892, v. 12, p. 369.
- Gazanias*, The Garden, 1895, v. 47, p. 288.
- Catasetum*, Gard. Chron. 1899, v. 6, p. 559.
- The genus *Drosera*, Gard. Chron. 1883, v. 19, p. 732.
- The Genera *Plantarum*, Gard. Chron. 1883, v. 19, p. 733.
- Mesembryanthemum edule*, Gard. Chron. 1885, v. 24, p. 266.
- Fertilisation of *Hoyas* and other *Asclepiads*, Gard. Chron. 1885, v. 24, p. 435.
- Three new *Anthuriums*, Gard. Chron. 1885, v. 24, p. 650.
- Mesembryanthemum ficiforme*, Gard. Chron. 1886, v. 25, p. 373.
- New Plants introduced into cultivation, in The Gardeners' Year Book and Almanack, 1876 onwards, continued in the Journal of Horticulture and then in the Kew Bulletin, without author's name.
- Supplement to Johnson's Gardeners' Dictionary to end of 1880.

- English Botany, ed. 3, v. 12, and Supplement.
Four New Genera of Aroideæ, Journ. of Bot., v. 20, p. 193.
The Tonga Plant, Journ. of Bot., v. 20, p. 332.
On some new Aroideæ, Journ. Linn. Soc., v. 18, p. 242.
Vaccinium intermedium, Ruthe, Journ. Linn. Soc., v. 24, p. 125.
New and Old Species of *Mesembryanthemum*, Journ. Linn. Soc.,
v. 45, p. 53.
Editing and notes added to Dr. Bolus' Contributions to South
African Botany, Journ. Linn. Soc., v. 20, p. 467-488.
On the genus *Pergularia*, Kew Bull. 1907, p. 323.
On *Telosma*, Coville, Kew Bull. 1908, p. 86.
On *Fockea capensis*, Kew Bull. 1909, 6. 350.
Euphorbia caput-medusæ and *E. multiceps*, Kew Bull. 1912,
p. 246.
Euphorbia meloformis, Kew Bull. 1912, p. 301.
Euphorbia Tirucalli, Kew Bull. 1914, p. 94.
Euphorbia pubiglans and *E. enopla*, Kew Bull. 1916, p. 44.
Echinocactus ornatus, Kew Bull. 1913, p. 63.
On the genera *Cordyline*, *Dracæna*, *Pleomele*, *Sansevieria* and
Tætsia, Kew Bull. 1914, p. 273.
History of *Aloe spicata*, Gard. Chron. 1921, v. 70, p. 6, 16.
Mesembryanthemum and some new genera separated from it,
Gard. Chron. 1921, v. 70, p. 125, 138, 151, 172, 207,
223 and onwards.
Les Cyripediæ, (The French translation of the text by
Godefroy Lebeuf).
Veronica cupressoides and its allies, Gard. Chron. 1888, v. 3,
p. 20.
Also scores of descriptions and notes in the volumes of the
Gardeners' Chronicle, from 1876 to present date.
Ditto, ditto, in the "Decades Kewenses" and "Diagnoses
Africanæ," published in the Kew Bulletin.
Also numerous plates in the Botanical Magazine.
Ditto, ditto, in Hooker, *Icones Plantarum*.
Ditto, ditto, in *L'Illustration Horticole*.
Numerous articles and notes upon Microscopical matters, in the
English Mechanic and World of Science, including a paper
upon Antarctic Diatomaceæ.

*A Preliminary Note on the Flora in the neighbourhood of
Bethlehem, O.F.S.*

By E. P. PHILLIPS, M.A., D.Sc., F.L.S.
Division of Botany, Pretoria.

The following notes have been got together as the result of a short visit to Bethlehem at the beginning of December, 1919. The locality is an extremely interesting one as in quite a small area various types of habitats may be met with each carrying a different flora. Mr. Theo. Potgieter B.A., who accompanied me when out collecting is following up this work and as he is resident in Bethlehem he will be in a better position to do justice to a descriptive account of the flora. No work of this description has been yet attempted in any detail for the Orange Free State and if workers can be found in other localities to undertake the collection of the plants and the writing up of the results of their observations our knowledge of the flora of this large area will be materially advanced. The general notes given here may be a guide to collectors who are anxious to make some field observations as a supplement to their collecting.

The town of Bethlehem is partly surrounded by dry stony kopjes beyond which are large expanses of grass veld. To the N.W. of the town is a flat kopje of cave-sandstone—an outlier of the formation which is commonly met with further eastwards—and it was only on this kopje that bush was met with. At the lower end of the town is the river which runs down a ravine and then broadens out into more or less stagnant water. The river in some places is lined with willows and higher up on its banks pines have been planted. Under the shade of these trees and on more or less damp ground a species of *Bromus* is dominant and growing among the grass occasional specimens of *Geranium incanum* are met with. Further away from the river bank and

out of the influence of the damp soil the *Bromus* disappears as the dominant species and flowering plants are more common. Specimens of *Acalypha peduncularis* are common, and such species as *Sutera aurantiaca*, *Arctotis* sp., *Helichrysum latifolium*, and *Cluytia natalensis* are frequent. *Themeda triandra* (Rooi-grass) is only found outside the *Bromus* zone. In some places the river widens and becomes shallow but still shaded by the overhanging willows. The middle of the stream is usually covered by a bamboo but in shallow places the dominant species are *Conium chaerophyllioides*, *Ranunculus pubescens* and *Bromus* sp. Growing actually in the water are *Veronica anagallis*, *Rumex echlonianus* and *Juncus* sp. Several *Cyperaceae* are common such as *Cyperus marginatus* which forms isolated clumps, and *Cyperus distans* found on wet ground. As the stream is ascended it narrows and flows over rocks. On one side are broken perpendicular cliffs on the other a steep kopje, while usually for a short distance on either side of the stream are grassy banks. The cliffs are covered with plants of the stunted bush type but many smaller species are found in the crevices of the rocks. Some of these are *Mohria caffrorum*, *Pellaea hastata*, *Felicia muricata*, *Tricholaena setifolia*, *Peponia caledonica*, *Ornithogalum subspicatum*, *Hypoxis villosa*, etc. At the foot of these cliffs are a few bushes such as *Leucosidea sericea*, *Cluytia natalensis* and *Myrsine africana*. The grasses on the banks of the stream are *Harpechloa capensis*, *Eragrostis brizoides*, *E.* sp., *Andropogon appendiculatus* and *Themeda triandra*. Nearer the stream in more or less wet soil are plants of *Lobelia Erinus*, *Pennisetum Thunbergii* and *Kyllinga erecta* while lining the banks and growing in the water is a fringe of *Cyperus distans*. The slopes of the kopje are dry and covered by small shrubs; the two most common being *Artemisia afra* and *Cluytia natalensis*. A species of *Bulbine* is conspicuous owing to its large yellow inflorescence. Among the boulders are many shade-loving species such as *Phytolacca heptandra* and *Stachys malacophylla*. At the junction of the bush and grassy bank of the stream are found patches of *Tulbaghia* sp. Other species found in flower on the slopes are *Senecio hastulatus*, *Asclepias eminens*, *Clerodendron triphyl-*

lum, *Anthericum Gerrardi*, *Eriosema salignum* and *Pachycarpus rigidus*.

The sandstone (cave-sandstone) kopje mentioned above lies to the west of the village and rises about 300 ft. above the level of the plain. It is approached over an open grassy slope which higher up becomes steeper and broken, the ground usually being covered with boulders. From these steep slopes the sand-stone cliffs rise abruptly and have vertical faces 20-30 ft. high. The cliff wall is however not continuous but here and there is broken and the grassy slopes reach the summit of the kopje and form small valleys. On the lowest open grassy slopes the dominant species are *Ranunculus pubescens* and *Helichrysum aureo-nitens*. Scattered over the slope are small bushes of *Rhus dentata* and in patches *Berkheya ingrata* is common. Occasionally specimens of *Helichrysum rugulosum* and *Scabiosa columbaria* are met with and under the shade of *Rhus dentata* are often found plants of *Salvia repens*. Common on these slopes also is *Ajuga Ophrydis* while *Rhynchosia adenodes* is frequently met with. The grassy valleys have much the same flora in parts but *Aster hispidus* and *Elephantorrhiza Burchellii* appear to be confined to these habitats.

As one enters the broken ground on the higher and steeper slopes a few species are met with which are not present lower down. The most common of these is *Senecio isatidens* (just coming into flower). *Thesium* sp. (No. 3170) and *Pollichia campestris* are fairly common, the latter species is usually confined to sheltered places between boulders. Small shrubs of *Anthospermum rigidum*, 6 to 9 in. high, are occasionally met with and a few specimens of *Schizoglossum biflorum* were taken, though this species is rather rare.

Below the perpendicular cliffs the vegetation forms definite bush made up of varying components, although in some places it is almost pure *Calpurnia intrusa*. The more common species found in the bush are *Cluytia pulchella*, *Rubus rigidus*, *R. Ludwigii*, *Myrsine africana*, *Gymnosporia buxifolia*, *Rhus dentata* and scrambling amongst these is *Asparagus Cooperi*. Right up against the cliffs are specimens of *Plectronia ciliata*, *Halleria lucida*, *Myrsine africana* and *Heteromorpha arborescens*. Only one plant

was found approaching anything like the dimensions of a tree, viz., a specimen of *Heteromorpha arborescens* which was growing on the face of the cliff and was about 15 ft. high. The bush is broken here and there with small glades. In these habitats are found *Agrimonia Eupatoria*, *Felicia muricata*, *Valeriana capensis*, *Senecio isatidens*, *Pentanisia variabilis*, *Vernonia hirsuta*, *Indigofera hedyantha* and *Thesium scirpoides*. Intermingled with the bush are scattered plants of *Artemesia afra* up to 3-4 ft. high, and in the shade specimens of *Mysotis sylvatica* and *Mahernia chrysantha* are frequently met with. Outside the bush *Senecio othonnaeflorus* is very common.

The summit of the kopje is flat and shows some very interesting changes in the dominance of particular species. In places where the sandstone is exposed the dominant species is *Calpurnia intrusa*, but when the sandstone is well covered with soil *Indigofera melanadenia* becomes dominant. In the neighbourhood of the *Calpurnia* area are found *Myrsine africana*, *Rhus erosa* (usually on rocky ground rather than open spaces) *Senecio bupleuroides*, *Hedyotis amatymbica*, *Gazania longiscapa*, *Senecio Burchellii* (occasional), *Lightfootia albens* (occasional), *Polygala rarifolia* (usually in sheltered places). A species of *Ursinia* (*U. montana*) a small shrubby plant addressed to the rocks is found occasionally and usually in rock depressions. The only succulents met with are *Crassula nodulosa* and two species of *Mesembrianthemum*. In the area of *Indigofera melanadenia* are scattered bushes of *Metalasia muricata* and occasionally among the rocks are seen specimens of *Anthraxia elata*. In some patches *Rhus discolor* is frequent. Where the soil is sandy and of greater depth such species as *Berkheya setifera*, *Helichrysum latifolium*, *Ajuga ophrydis* and *Hypoxis obtusa* are met with.

Many of the flat rocks on the summit have large shallow depressions in which water collects during the rainy season. A detailed study of the plant succession in these pans will yield some interesting results as showing the various changes that take place in the covering of the bare rock with soil in which the larger species mentioned above are able to live. One pan that still contained water was found and in this were five species.

In the wet sand and growing subsocially are *Cyperus rupestris* and *Crassula laxa* while in the water are *Crassula natans*, *Crassula parvula* and *Lobelia* (*Metzleria dregeana*). As evidenced by many of the dry pans examined the above must be regarded as a stage in the plant succession which forms a bed on to which the grasses first migrate followed by such species as *Metalasia muricata* and *Indigofera melanadenia*.

The bulk of the species found in the localities described above are plants with underground resting winter buds. The leaves are simple, sessile, broad, entire and glabrous; the flowers medium in size and of a yellow colour; the fruits capsular. This statement is based on a detailed examination of the various organs.

If we exclude the glumaceous monocotyledons we find that 71·8 per cent. of the species have sessile leaves and 28·1 per cent. have petioled leaves. Simple leaves are represented by 76·3 per cent. of the species and compound leaves by 23·6 per cent. The difference between glabrous and hairy leaves is not so great—59·0 per cent. glabrous and 41·0 per cent. hairy. The latter is made up as follows:—Pubescent leaves 20·9 per cent., woolly leaves 10·9 per cent., tomentose leaves 7·2 per cent., hispid leaves 1·8 per cent. Incisions (incised, crenate, dentate, serrate, etc.) on the margins of the simple leaves (or the leaflets of compound leaves) are uncommon and are only met with in 11·8 per cent. of the species while 88·1 per cent. of the species have entire leaves. Most of the species have broad leaves (50 per cent.), linear leaves are met with in 42·7 per cent. of the species while ericoid leaves are rare (7·2 per cent.).

In comparing the size of the flowers one can only make relative comparisons. Species with conspicuous flowers or flowers massed in a conspicuous inflorescence comprise 28·1 per cent. of the total number of species; medium-sized flowers are found in 44·5 per cent. of the species and small or inconspicuous flowers in 27·2 per cent. of the species. The predominant colour of the flowers is yellow (43·6 per cent.). Other colours represented are white (20·0 per cent.), red (12·7 per cent.), blue (10·9 per cent.), green (9·0 per cent.), purple (2·7 per cent.), and brown (0·9 per cent.).

Taking the flora as a whole, *i.e.* including the Cyperaceæ and Gramineæ a study of the fruits shows that 49·2 per cent. of the species have capsular fruits, 42·0 per cent. have achenes, while only 8·7 per cent. of the species have succulent fruits.

The bulk of the species are Hemicryptophytes (52·5 per cent.), *i.e.* with the resting winter bud below the surface of the soil; Chamæphytes *i.e.* plants with the winter buds a few inches above the soil comprise 10·3 per cent. of the species; bushes (Nanophytes) form 9·4 per cent. of the flora. Water plants (Hydrophytes) are frequent and comprise 11·2 per cent; bulbous plants and annuals are not so common, the former make up 9·4 per cent. and the latter 6·0 per cent. of the total number of species. As mentioned previously only one plant was met with approaching the dimensions of a tree.

Systematic Constituents of the Flora.

| | Order. | Genera. | Species. |
|----------------|--------|---------|----------|
| Dicotyledons | 33 | 67 | 96 |
| Monocotyledons | 5 | 22 | 30 |
| | <hr/> | <hr/> | <hr/> |
| | 38 | 89 | 126 |

Proportion of Monocotyledons to Dicotyledons 1: 3·2

Proportion of Genera to Species 1: 1·4

PREDOMINATING ORDERS.

| <i>Number of Species.</i> | <i>Percentage of Whole.</i> | |
|---------------------------|-----------------------------|------|
| Compositæ | 20 | 15·8 |
| Gramineæ | 10 | 7·1 |
| Liliaceæ | 10 | 7·1 |
| Leguminosæ | 8 | 6·3 |
| Asclepiadaceæ | 7 | 5·5 |
| Cyperaceæ | 5 | 3·9 |

With regard to the affinities of the flora in the neighbourhood of Bethlehem no definite statement can be made until it is better worked. I have no hesitation, however, in stating that from the observations made on the short visit that the flora in this locality will prove to be intermediate between that of the High Veld of the Orange Free State and the Eastern Mountain Region. The presence of cave-sandstone brings in a flora belonging to the latter Region and most of the species collected on this formation are eastern rather than O.F.S. High Veld. The order of importance of the natural Orders:

1. *Compositae*.
2. *Gramineae*.
3. *Liliaceae*.
4. *Leguminosae*.

also shows a relationship with the Eastern Mountain Region as does also the higher percentage of the *Compositae*. The absence of *Ericaceae* and *Orchidaceae* (at least none were collected) is significant. The presence of a large heath and orchid flora in the Eastern Mountain Region is one of its outstanding features. It would appear therefore that the area round Bethlehem is for the greater part under the influence of the conditions prevailing in the Free State and that the intrusion of cave sandstone with its distinct flora is alone responsible for the affinity with the Eastern flora.

Similar conclusions to the above will no doubt be reached if various localities bordering on the boundary of the Eastern Mountain Region are examined. The western boundary of this Region might then be mapped with some accuracy, but I doubt whether it will be very materially altered.

1. Phillips. Contributions to the Flora of the Leribe Plateau.—
Ann. S. Afri. Museum xvi. 1. plate 7.

Note on Aponogeton distachyon



Note on Aponogeton distachyon.

By INEZ C. VERDOORN, Division of Botany, Pretoria.

Through the courtesy of the Director, National Botanic Gardens, Kirstenbosch, the Division of Botany at Pretoria received a few living plants of *Aponogeton distachyon*. These were grown in the greenhouse in a large glass tank in which some soil had been placed.

The plant is a typical water plant with flat leaves, which are borne on long petioles and float on the surface of the water. The inflorescence consists of a number of naked flowers each subtended by a fleshy white bract.

The writer had facilities for keeping the plants under constant observation and has recorded the following few notes on the life-history which appear sufficiently interesting to warrant publication.

In March, each plant developed a "flower" bud which was enclosed in a green sheath. This sheath splits in a circumscissile manner at the base and falls off as a cap exposing the young inflorescence. At first the two arms of the inflorescence are appressed hiding the flowers but they eventually separate and expose the crisp white fleshy bracts which surround each flower. The bracts soon expand and the individual flowers consisting of 3 to 4 white carpels surrounded by about 8 brown anthers are seen. As the flower matures, the filaments of the stamens elongate until they reach the height of the carpels; the anthers then dehisce and shed their pollen.

The method of pollination was not clearly observed but as fruits ripened pollination must have taken place.

After pollination and as the fruit matures the whole inflorescence becomes green. At maturity the carpels split at the apex, the pericarp curls back and exposes the seeds (sometimes only one seed is formed) which escape and float on the surface of



the water being enabled to do so by means of an oily testa. After floating for eight days the testa splits and the "seed" sinks and germinates in the soil below.

Within four days of sinking a long slender structure appears and grows towards the surface of the water and a few days later two radicles, one at the apex of the "seed" and one next to the plumule appear. They grow into the soil and fix the young plant. On reaching the surface of the water the apex of the structure which first appears from the "seed" bends at right angles, becomes flattened and forms the lamina of the leaf.

In connection with the germination of *Aponogeton distachyon* Dr. Marloth (Trans. S. Afr. Philos. Soc. vol. 8. p. LXXX) states that "the seed germinates while floating on the surface and gradually forms the bulb. When this becomes heavy enough it sinks, and the plant fixes itself permanently." This does not agree with my observations made on plants grown at Pretoria as germination took place below water, except in one instance when the seed did not completely escape from the oily testa and in this case germination commenced on the surface.

Explanation of Plate.

Fig. A.—Mature plant with leaves only.

Fig. B.—Young inflorescence before opening.

Fig. C.—Inflorescence with surrounding sheath beginning to split.

Fig. D.—Expanded inflorescence.

Fig. E.—Carpel with pericarp.

Fig. F.—Seed.

Fig. G.—Seed escaping from testa.

Fig. H,I,J.—Stages in germination of seed.

Fig. K.—Mature root system.

*Notes on the Distribution of Species in Natural Forests of the
Transkeian Conservancy.*

By O. B. MILLER, Department of Forests.

Schimper (p. 160. "Plant Geography") in discussing the differentiation of the Earth's vegetation says: "The type of the flora in so far as it depends on existing factors is dependent primarily on heat.....Heat determines the flora, climatic humidity the vegetation."

This general rule well explains how it is that a tree like *Trichilia emetica* which occurs in tropical Africa cannot, in the Cape Province, exist away from the coast.

But among our coast trees there are many that extend far inland to what is practically the limit of forest-growth (6,000 feet) and these usually find their optimum at altitudes ranging round 3,000 feet. Many coast forests and sheltered bluffs above the sea support real yellowwood (*Podocarpus thunbergii*). This species is found wherever climatic humidity permits woodland to exist, from the sea to the tops of the mountain range traversing the Transkei, known variously as the Insizwa, Nungi, Mgano and Matiwane. Thunberg's yellowwood is one of the least exacting of our forest trees as, on the upper mountain slopes, it withstands the rigours of climate so much better than its associates that it forms in many parts almost pure forest. In such places its principal competitor is *Olinia cymosa*, a tree whose range seems limited to the mountains.

Gradually one comes to know roughly what may be expected to occur in a given locality and the presence of certain species, such as white ironwood (*Toddalia lanceolata*) is taken for granted in every wood in the Transkeian Territories. It grows at sea level and Bews reports it from the uppermost Drakensberg forests. Its almost complete absence from the Mgana Range is therefore a matter of surprise. These mountains run from the Tina River to Lady Kok End on the Kinira River. The

natives state that "Mzane" (*T. lanceolata*) does not grow in any forest on these mountains. The writer however found a single seedling about 2 feet high in the Ntshontsho Forest (Trinity or Cancels sub-reserve). No parent tree was to be seen. Sneezewood (*Ptaeroxylon utile*) is another tree whose range is uncertain. It is abundant in many coast forests. It forms magnificent boles in mountain forests. It grows, at about 2,500 feet, as scrub on the krantzes above the Umtata Falls in shallow soil and an exposed position. It is to be found in most of the Western Tsolo mountain forests, but entirely disappears on these same mountains in the Bazeya patrol across the boundary of the Umtata District.

Both white ironwood and sneezewood have shown themselves able to thrive wherever forest exists, so that climate can be eliminated as a deciding factor as to where they shall or shall not be.

They show equal disregard for the origin of the soil in which they grow, Table Mountain Sandstone, Eccca, Beaufort, Molteno beds of the Stormberg series and dolerite all provide for them. Their distribution is uninfluenced by geological factors.

In the Mount Frere district near the fence that divides it from Matatiele there are five small patches of destroyed forest, none more than three acres in extent. The natives say that a few years before rinderpest these woods were like those on the Nungi Hills, which lie two miles distant, i.e. mountain high forest of fair quality. Then the people began to cut and to-day the floor is grass and weed-grown. The only present evidence that these were once forest is an occasional large stump. There are a few pollarded cussonias. Otherwise sparse coppice and shrubs are scattered among the grass and weeds. Even the old tree stumps have been hacked away for firewood.

These erstwhile forests lie at an elevation of about 4,000 feet mainly on the left banks of small water-courses running from west to east, and face the south. The soil lies over Beaufort sandstones, and is a sandy clay of varying depth. Towards the bottom of the second forest there is an area of almost pure sneezewood coppice, where, within twenty years the Matatiele farmers split poles from wellgrown sneezewoods with a girth

of about twenty inches. They came to this little wood because there was no other sneezewood in any forest for miles around.

A little over two years ago the headman told his people they must stop cutting the sneezewood coppice. To-day sprouts are 6 feet to 8 feet high, rather crooked but vigorous. The largest stump to be found was 10 inches across, a little above the ground. The larger ones have all been hacked away by women. Here and there among the sneezewood are small *plectonias* and some *Dais cotinifolia*.

In the forests of the Matatiele Main Reserve and the Mount Frere Eastern Reserve which surround the little patches referred to and which are known to the natives as the Datyane, are to be found precisely similar conditions. But sneezewood is, it is believed, altogether absent, and is not found any nearer than Insizwa forest seven miles away, as the crow flies; nor does it occur in the opposite direction until one comes to Nyushweni on the Qumbu border of Mount Frere, twenty-two miles distant.

The writer was once enjoined by a well known artillery brigadier, to state facts and leave senior officers to draw deductions. However, in the most tentative fashion he suggests that, apart from heat, distribution is chiefly influenced by animals.

A winged seed like that of the sneezewood is not likely to travel more than a few hundred yards from the parent tree. On a high gale it may be transported far afield and, exceptionally, a seed may be carried to a distance in mud caked to the foot of a buck or bird.

Normally the seed must find a seed bed within a reasonable distance and that must be in a spot climatically suited to forest growth. Since man has destroyed the dense sugar bush and the "fringing" forests that formerly linked up the high forests, this means of egress is denied. Similarly bush buck are not likely to travel far from high forest over open country.

Even supposing a seed was accidentally transported and germinated in a forest where none of that particular species grew, in the case of dioecious trees like sneezewood and white ironwood, there would be no reproduction of its kind.

The case is far different with succulent fruited species. Such trees as black ironwood (*Olea laurifolia*) that are aided in seed dispersal by birds, especially parrots—wild fig (*Ficus* spp.) especially by the migratory green pigeon—will spread if such birds, living in forests where a particular species is absent, will go far enough afield to forests where such species abound and return to deposit the seeds. By such means will the gaps in the seed-bed be bridged.

In brief the idea is that heat is the chief determining factor. Otherwise, speaking generally, trees will grow in any forest soil, and species which do not naturally occur owe their absence to lack of opportunity due to want of seed-dispersal or pollinating agents, rather than to edaphic reasons.

Experimental plantings, intelligently and carefully carried out, if successful, will at least, strengthen this suggestion.

*On Land Connections and the former extent of the
African Continent.*

*An Address delivered before the Pretoria Branch
of the S.A.B.S.*

By DR. E. C. N. VAN HOEPEN, M.I.

South Africa presents to the student of animal and plant distribution many problems, which are still being explained by many, and therefore unsatisfactory, hypotheses. Our nature demands an explanation of some sort. Hypotheses are thought out, criticised and dropped for better ones in a continuous string. The most fascinating, and therefore the most tenacious, are those grand ones, which are supported by a few facts of the same character and which cannot be contradicted, or only with great difficulty, by facts of another character.

The geologist, who finds deposits with the same plant remains in South Africa, Southern India and Australia, is easily led to the conclusion, that these land-deposits are remnants of a vast continent, which once connected the distant portions and covered the whole of the Indian Ocean.

The zoologist, who finds the nearest relation of a South African animal in South America, has bridged the enormous gap between the two sub-continentes by a direct thought, and the next step, that of consolidating this frail connection into a more substantial land bridge, seems to be an easy matter.

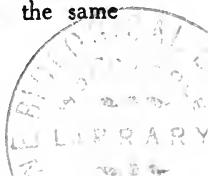
The palæontologist is struck by the remarkable resemblance between the North American Permian fauna and that of our Karroo rocks. The fauna of these two regions is already so largely known, that he is constantly searching for and finding the ties of relationship between them. The construction of the land bridge, which had to secure his objects of study an easy walk-over, has offered no special difficulties. Neither of these

scientists has ever troubled about the disposal of the vast mass of water to be displaced by these hypothetical continents.

It is of the greatest interest to the biologist to know exactly or at least as near as possible, how land and water were divided in the course of time. Grand conclusions are often based on palæogeographic maps constructed on extremely meagre facts, and to this method we owe our great number of hypotheses on the distribution of species. If the facts, which moved the student to the construction of land bridges, are carefully examined, it will be found, that they can also be explained in some other way and that, therefore, those land connections are not necessary. This is especially the case with the African continent except for its northern and north-eastern limits, where connections with Europe and Asia must be accepted. There is no valid evidence to prove, that Africa was ever connected with any other continent and I therefore put the following thesis: Africa has always been ocean bound except in the north and north-east, where it was occasionally connected to Europe and Asia.

We will first examine the geological evidence, amongst which the stratigraphical is the most important. The latter evidence may be divided into two sections, that which depends chiefly on the determination of facies and that which is afforded by the great marine transgressions. In identifying the facies we determine the presence of land or water at a certain spot or the relative distance of a former seashore at a given time. The same may be done for other localities, and the surest conclusions will be gathered if these localities are many, close together and when the studied phenomena lie within the narrowest possible time limits.

Rocks of Santonian (Upper Cretaceous) age have been found on different parts of our east coast. In Pondoland the coastal deposits of this age form the coast of to-day, the deposits even entering present river channels. There can therefore be no doubt, that at the time when these beds were deposited the Pondoland coast was right where it is now. Further north, in Natal and Zululand, rocks of the same age occur at some distance from the present shore. In Kenya rocks of probably the same



age occur, and in Egypt rocks of the same age have been discovered. There are rocks in Algeria which I regard to be of identically the same age as those of Pondoland. I am not aware of beds of Santonian age on the west coast of Africa. In this way a string of points is obtained which fix a former coastline and make it pretty certain, that Africa was sea-bound, at least in the North and in the East, during Santonian times.

Lower Cretaceous rocks of exactly the same geological subdivision occur on the south and east coast of the Cape Province, in Kenya, in Algeria and Tunis, in Cameroon and probably in Angola. It would seem, therefore, that Africa was also surrounded by water in Lower Cretaceous times. Marine littoral deposits of Eocene age occur in Tunis, Algeria and Morocco, in Senegal, in Togo, in Nigeria, at the mouth of the Congo, in Southern Angola, Kenya, Egypt and in Cyrenaica. This chain is laid all round Africa and one is led to the conclusion that Africa was also ocean-bound in Eocene times. The weak side of these conclusions is that they are based on a few points, which are often a great distance apart. An extension of our knowledge into these gaps may work considerable changes. Further, the different points of the supposed shore may as well be points on shores of islands.

The Dwyka tillite occurs over a vast extent of Africa. There is no doubt whatever that it owes its origin to continental glaciation and that at least those parts of Africa where it occurs formed an early Permian land surface, except perhaps in South West, where it contains marine fossils.

The same deposits occur in India, Australia and South America and one may conclude, that these countries also were land surfaces under a continental ice cap at the beginning of Permian times. It seems that this is about all one can safely conclude from the given facts. Others, however, go further, and unite all the mentioned countries into one vast continent. This would then account for the uniformity of the deposits and for the origin of many of the pebbles contained therein. The ground moraines of the Diluvial Ice Age in Europe are of the same type as those in North America, and they would naturally be

as the results of identical phenomena, but one would not want to unite America with Europe across a North Atlantic continent to explain this. Neither will we be able to explain the present glaciation of Greenland, North America and Nowaja Semlja by uniting all these parts into one continent, because we know they belong to separate and distant landmasses. It is therefore not necessary to unite the different parts of the supposed "Gondwanaland" for this reason alone. As to the unknown origin of many of the pebbles contained in the Dwyka tillite, it is one of the most difficult problems to find the origin of the pebbles in the moraines of the Diluvial Age and it will be infinitely more difficult to do so for the moraines of an Age so remote as the Permian.

One must be very careful in uniting identical deposits, which lie far apart, into vast continents. Those who have seen the Keuper deposits of Germany in Thuringia and the Lystrosaurus Beds of the Orange Free State will agree that the variegated marls especially bring one under the impression that these deposits are identical. Yet it is generally accepted that at the time of their deposition Europe and Africa were separated by the great Mediterranean sea called Thetys.

There is abundant evidence of the Cenomanian transgression in Africa. Vast stretches of Northern Africa were under water in Cenomanian times, and deposits of this Age have been found, often covering much older rocks, in Cameroon, Angola, Madagascar, Kenya and Natal. To these I may add two new localities, the one lying about twenty miles north of Komatipoort, east of the Lebombo and about forty miles from the nearest coast, and the other near the southern border of Portuguese Territory, about ten miles from the Lebombo heights and about thirty miles from the coast. There is in my mind no doubt, that the Cenomanian deposits form a continuous belt from Kenya right down to Natal. The African continent was considerably reduced in Cenomanian times and it is very probable that land bridges which might have existed in previous times between Africa and Eurasia were then submerged. On the other hand, as recently pointed out by Prof. Stromer, the mediterranean sea

was apparently regressing during the Oligocene and it is therefore possible that land connections between Africa and Eurasia came into existence again. Biological facts demand the presence of such a land bridge at that time and the geological possibility is therefore of value.

Another group of geological evidence is of a tectonic nature. The Karroo Formation in South Africa forms in the main a basin, which is closed along its southern and western sides, and which flattens out towards the north. Its eastern border, however, breaks off abruptly on the south east coast, and this may be regarded as definite proof, that this land deposit once extended further. But there is no proof whatever for a connection with another continent.

It so happens that some mountain ranges in Africa agree in age and direction with such of the South American continent. This phenomenon has, also recently, been used as proof of former connection between the two continents. Special attention has been drawn to mountain ranges south of Buenos Aires which have a NW.-SE. trend and which are compared with mountain ranges practically parallel with our SW. coast and therefore with the same trend. Such phenomena could possibly be explained as the result of identical stresses but never as proof of former continental connection.

Other evidence is afforded by geomorphological and geophysical phenomena. The river channel of the Congo continues for nearly a hundred miles over the seabottom and it is quite clear, that the river can only have eroded it on a land surface. This, therefore, gives certain proof, that formerly the African continent at this point extended at least one hundred miles further westward. Similar submerged river channels have also been noticed on our south east coast which furnish further proof of submergence of a portion of our continent in this region. I cannot accept the view of Dr. Matthews, who tentatively explains the undersea channels as having been formed by seaward growing barrier reefs, the channel representing the course of the river, in which the corals could not live. Reefs only grow near the surface. The reefs which formed the channel of the Congo,

where are they now? Sunken to abysmal depths? But then we may as well accept the possibility that the river mouth disappeared under the sea. I have just now mentioned, that the Cenomanian seas reached the foot of the Lebombo mountains. It is practically certain that this mountain range proved an effective barrier to the progress of the ocean, and represents the old coastline of Cenomanian times. Incidentally this would mean that the age of the Lebombo mountains is precenomanian.

Wegener has recently ventured a grand explanation for the existence of the Atlantic Ocean and for the parallelism of its east and west coast. According to this hypothesis the Atlantic Ocean is nothing but a gradually broadening cleft between the great continents. Most of the difficulties of the land-bridge builders would be solved as also most of the objections against them, for Africa and South America were formerly one continent and they have only in geologically recent times been rent asunder.

One of the supports of the hypothesis is the parallelism of the west coast of Africa with the east coast of South America. However, this supposed parallelism is not established, for if carefully compared it will be found that the two coast-lines will not fit into each other. If the 2000 meter line be taken as the border of the continental shelf, we get a fairly straight north-eastern border of South America which makes a practically right angle with a nearly straight south east coast. The same line along the African coast leaves a big bight along the coast of Nigeria which is indented opposite the mouth of the Niger. The southern border of north west Africa is then an undulating line, which makes with the undulating western border of South and Central Africa an angle of about 110 degrees. In the first place, therefore, neither of the straight borders of South America will coincide with the undulating borders of Africa and secondly, if one of the borders is fitted as near as possible on to the corresponding one of the other continent the two other borders will not coincide but form an angle of twenty degrees with one another. An attempt to fit together the 4000 meter lines fails altogether.

Further support for the hypothesis has been sought in corresponding tectonic phenomena and special attention has been drawn

to the parallelism of the mountain ranges south of Buenos Aires and on our south west coast. Just now mountain ranges south of Buenos Aires were mentioned which have a NW.-SE. trend and which have therefore the same trend as mountain ranges on our south-west coast. The South American mountains have therefore a trend which is nearly rectangular to the two thousand meter line of their coast. The mountain ranges near the west coast of the Cape Province are practically parallel to this coast, and therefore if the South American coast is fitted on to the African west coast it will be found that the mountain ranges South of Buenos Aires, the Sierra Tandil and the Sierra de la Ventana, make a large angle with the Olifantsbergen, Bokkeveldbergen and Cederbergen of the Cape.

Stromer draws attention to the fact that the Cameroon line, a tectonic line running from the Cameroon Mountain perhaps to St. Helena, passes from the sea bottom into the continent, and that this could not be if Africa were floating on the heavy rocks constituting the sea bottom. Where this must be accepted as a proof of the stability of the African continent, it can still be argued, that it is America which is floating away from Africa.

Another hypothesis is that of the permanence of oceans and continents. A weighty argument in its favour is, that there would not be place for the enormous masses of water, which would be displaced by a South Atlantic or a Gondwana continent. If deep sea ever existed on places which are now land, it would be possible to prove this from deep sea deposits there. However, real unquestionable deep sea deposits have not been found on any continent yet.

Another group of evidence is based on biological facts. The occurrence of the same species or genera or allied forms in two continents is very often explained by connecting them through land bridges. From the number of common or allied forms is judged the distance in time of the existence of the land bridge. When the percentage is high the land connection was recent. In this way we come to land bridges in recent times across the Mediterranean and the Red Sea. However, it has also been thought necessary to have a land bridge between West Africa and Brazil in Tertiary times in order to explain the occurrence of fresh

water fishes and land plants common to both continents. A land connection is also required between Madagascar and southern India (Lemuria continent) because of the common presence especially of lemurs. The presence of *Glossopteris* in the Permian deposits of South Africa, India and Australia, has been regarded as a proof of the existence of the Gondwana continent as also the occurrence of *Anomodonts* in the same beds in India and South Africa. This Gondwanaland must have reached over the Atlantic to Brazil, because the *Glossopteris* Flora occurs there too and because representatives of the family *Mesosauridae* occur in Permian deposits of South America and South Africa.

Now, none of these land bridges are necessary, except those connecting Africa and Eurasia. All the phenomena which they have to explain, can also be explained in some other way. The land bridge of Tertiary times between Brazil and Africa has to explain the presence of allied fishes and plants on the two continents. No species or genus of fish is common to the two continents. With regard to the fishes, this land connection is based chiefly on the distribution of the *Characinidae* and the *Cichlidae*. The former family is confined to the fresh waters of Africa and Central and South America, while the *Cichlidae* also occur in Madagascar, Syria, India and Ceylon. The *Characinidae* are very generalised, or, in other words, very primitive; they are the most primitive of the six families of the *Ostariophysi*, to which belong the carps and the barbers. These last are spread practically all over the world. It is, therefore, very probable, that the more primitive types had a greater distribution than to-day, and this may account for their occurrence in the two continents. The *Cichlidae* had probably also a large distribution formerly. For an Eocene genus of North America can be referred to this family. Although representatives of the family *Galaxiidae* occur in fresh water at the Cape, at the southern end of South America, New Zealand and South Australia, this is not taken as a proof of former land connections for one species of the genus *Galaxias*, occurring in all these localities also lives in the sea. It is very probable that the *Characinidae* and the *Cichlidae* were originally sea fishes, which like most, if not all, primitive types retreated

into equatorial fresh waters, while their sea-living representatives have since become extinct.

I am only aware of a few plants which might be used to prove transatlantic connections. The Proteaceæ occur in South and Central Africa, South America, Australia and tropical Asia. If their distribution can only be explained by land bridges, then the four continents must have been united. On the other hand it is quite probable that the Proteaceæ had formerly a much larger distribution, which would account for their present occurrence. Their occurrence in New Zealand, New Caledonia and Madagascar suggests means of crossing ocean barriers.

The genus *Parkinsonia* might be called upon to prove some land connection. One species only occurs in South Africa, another only in Mexico, a third in Mexico and California, while a fourth and only other species occurs in the tropics and subtropics of the old and new world. This might be explained by a dispersal from the north. There is also a possibility of a phylogenetic explanation, but as long as botanists do not tell us which of the species is the most primitive, this will have to be left alone.

It will, therefore, be seen that there is no necessity whatever for a land bridge connecting Africa and Brazil and on top of this there is grave biological objection. A land bridge would have enabled whole faunæ and floræ to migrate. Instead of one or two genera the two regions would show hundreds and hundreds of identical genera and even identical species. There would be numerous genera typical to the two continents, which would not show a connection through the northern hemisphere. Where are these faunæ and floræ? They are not there, because the land bridge never existed. There is one difficulty connected with the Hystricidæ. However, where an eminent authority like Dr. W. D. Matthew cannot offer an explanation covering all facts, I shall leave the problem alone. I feel certain that the problem is of a biological nature. A land bridge between Africa and America would not solve it. The land bridges between Madagascar, India and Africa, which have been deemed necessary to explain the occurrence of certain mammals and birds on the island are also based on inadequate grounds. The

chief argument in their favour is the occurrence of lemurs in Madagascar. As shown by Gregory these lemurs have radiated out from a single type, the European Eocene *Adapidæ*, and it is very probable, that the ancestor of the Madagascar lemurs drifted over from the African mainland on a natural raft. There are a few small carnivores, some insectivores and some rodents and each of these groups has, according to Matthew, apparently evolved on the island from a single type introduced long ago by means of a raft. There is further a shrew, a bat, a hippo and a bush-pig. The shrew and the bush-pig have probably been introduced by man (the latter in accord with certain customs of the Malays), the hippopotami may have arrived by swimming, while the bats may have arrived by flight. The extinct ground birds of the southern continents and islands have developed from quite different flying birds. In "Die Banier" of May, 1921, Dr. Dreyer of Bloemfontein advocates a boggy land bridge between Madagascar and Africa in relatively recent times, and explains the absence of bog-living antelopes from the island by assuming, that they had not arrived in Africa during the existence of this bridge. We must then assume either the same for the elephant, rhinoceros, warthog, monkeys in fact for a large part of the African fauna, or that the land bridge was too boggy for them. This last, however, is difficult to conceive, especially from the physical point of view.

The distribution of the *Glossopteris* flora and the Permian reptiles can find a much better explanation than by a Gondwanaland and South Atlantic. At the beginning of the Permian Period, South and Central Africa, India, Australia and South America were covered by ice. It is quite clear that under these circumstances no fauna or flora could exist. The fauna and flora which left remains in postglacial sediments must, therefore, have come from elsewhere. As the southern icefield advanced northwards the climate of the northern hemisphere became gradually severer. The Upper Carboniferous flora and fauna which still flourished in western Europe, suffered more and more under the change of conditions. Those species which, for some reason or other could not adapt themselves to the new conditions or could not migrate, became extinct. The flora and fauna which already

lived under severe conditions in high northern regions, would not be so heavily affected, indeed, the advancing cold climatic zone would only bring them a greater field for expansion. What animals and plants lived in Permian times in high northern regions? Amalitzky and Tschernyschew tell us that *Pareiasaurus*, *Dicynodon* and Theriodont-like reptiles lived together in northern Russia with a flora including typical members of the *Glossopteris* flora—for example *Glossopteris* and *Gangamopteris*—in Middle Permian times, or to be exact, before the deposition of the Russian Zechstein. The advancing cold climatic zone now came in contact with a similar association, to which it offered good living conditions. Had the cold zone advanced farther the remaining flora and fauna would possibly also have disappeared; however, its progress stopped. Then the temperature became gradually higher; the ice covering of the southern continents began to melt, and consequently its northern edge began to retreat southwards. The cold zone adjoining moved with it to the south and took its acquired fauna and flora with it. While the *Glossopteris* flora and the *Pareiasaur* fauna were moving southwards, the climate of Europe became milder and a new flora and fauna was formed by immigrants, by adaptations from local species, or by both. As the ice edge retreated further southwards the *Glossopteris* flora entered India, but probably there was no means for its accompanying fauna to do so too, for no remains of this fauna have yet been found in India. There must have been some land connection between Europe and Africa, for not only does the *Glossopteris* flora occur in the African lower Permian rocks, but remains of "theriodont"-like reptiles have been found in deposits, which are but slightly younger. *Pareiasaurus* came somewhat later. The *Glossopteris* flora also entered Australia from the North, but its associated land fauna could not follow. Whether the *Glossopteris* flora entered South America via North America cannot be made out. No members of the *Glossopteris* flora have been found in North America yet. There was no land connection with Africa for none of the African fauna occur in South America. But the land connection with North America must also have been broken off for the North American fauna has not passed over to South America. As the cold zone passed

on further southwards the climate of Africa, Australia and South America became milder, other species entered and began to compete with the existing fauna and flora which could not accompany its congenial climate further southwards or adapt itself to a new one and consequently died out.

It is not only the *Glossopteris* flora which dispersed southwards from the north. There are some Carboniferous types for example *Sigillaria Brardi*, *Lepidodendron*, *Annularia* and *Sphenophyllum*, which adapted themselves to the new climate and migrated with it southwards.

There is one difficulty in connection with the above explanation, which may not be passed without comment. The known *Glossopteris* flora of Northern Russia is of Middle Permian age, while the Dwyka tillite, in which members of this flora occur, is regarded to be of Lower Permian age. In the first place it appears to me perfectly legal to appeal to the imperfection of the palæontological record in the north, and secondly the doubt which is attached to the correlation of the Dwyka may here be emphasised. The formation of the Dwyka may have commenced at the beginning of the Rotliegende, but it need not have ended at the beginning of the Zechstein. Of the flora of high northern regions in Permian times only one locality has been discovered. Nothing is known of the Lower Permian flora of the high northern world.

The presence of *Anomodonts* in India and South Africa cannot prove the existence of a Gondwanaland, for these animals can have crossed over the mediterranean region.

West Africa and tropical South America are the home of the seacow, *Manatus*. This animal lives in rivers and shallow warm seawater. The conclusion has been drawn, that this animal can only have dispersed along the north coast of a South Atlantic Continent. The statement that this animal can only live in shallow waters is probably based on the fact, that it is never found anywhere else. However, the conclusion is not permissible, for the animal will naturally be found most often there, where its food, algæ, is most abundant. There is nothing to show, that it cannot live out at sea, when it has sufficient food to live on. Beddard states, that its former occurrence on the shores of St. Helena is

asserted. It would appear that the occurrence of food is an important factor in the distribution of this animal.

Although the Mesosauridæ have only been found in fresh water deposits in Africa and South America, it is not impossible that they could live in sea water too. Our knowledge of these animals is so scanty that it should be regarded as at least unsafe to use their distribution as proof of land connections.

A strong argument in favour of a land connection between Africa and Eurasia is the dispersal of the Proboscidea. These have originated in the early Tertiaries of Africa and they have dispersed in the later Tertiaries over the northern continents. There must, therefore, have been some connection between Africa and Europe during late Tertiary times.

In conclusion I wish to draw attention to an elaborate paper by Doctor W. D. Matthew of the American Museum, on Climate and Evolution, published in the Annals of the New York Academy of Sciences, Vol. XXIV., 1915, and to an article by Professor Stromer von Reichenbach recently published in the Geographische Zeitschrift on "Methoden paläogeographischer Forschung, erläutert an dem Beispiele einstiger Landverbindungen des afrikanischen Festlandes." I have read both papers with the greatest satisfaction and feel convinced that anybody who has read them carefully will banish hypotheses on land connections between Africa and India, South America and Australia into the land of myths.

Birds of the Buffalo Basin, Cape Province.

V.

By THE REV. ROBERT GODFREY.

Nicholson's Pipit—*A. nicholsoni* Sharpe: This species, which ranks as a scarce resident in the upper part of the Buffalo Basin, has proved in my experience one of the most tantalising of our local birds. It had been previously recorded from Kingwilliamstown in the month of May, but in my own experience it was obtained once only at Pirie, on 19th November, 1912, when my little hunters brought in three species of pipits, the Lesser Tawny Pipit, the Plain-backed Pipit, and Nicholson's Pipit. The last-named was accompanied by a fragment of the nest, the inner lining of brownish wiry roots with odd pieces of rougher material, and two eggs. The eggs, measuring 22.5-23 mm. by 16, are distinct from all other pipit eggs I have handled at Pirie; they are clouded white or stone in ground colour, profusely covered with purplish-brown and blackish-brown spots and blotches, forming a dark band near the larger end.

Lesser Tawny Pipit—*A. raalteni* Bp.: In the neighbourhood of the Pirie forest, the large Plain-backed Pipit is the predominating species, but, on the open grass-lands and cultivated areas away from the forest, the present species is much the commoner. From its characteristic mode of singing in the air, a habit in which it resembles the three British species, the Lesser Tawny Pipit claims attention wherever present. The bird rises almost perpendicularly, and in silence, to a height of forty or fifty feet, then flies along horizontally, uttering the single note of its song "tswee" thrice; a pause in the song follows, during which the bird may either keep on its horizontal course, or, more usually, may rise to a higher air terrace, where, in another horizontal flight, it repeats the song. The singer may repeat this manoeuvre as often as ten times, or it may be content with much less. At the

close of the performance, the singer descends abruptly, uttering its single note continuously during the descent; when near the ground it resumes silence and slides off gently along the surface to alight. My dates for the song are 27th August to February 15th, but I have also heard the song in May and in July, and I am not certain that this pipit has an actual break in its period of song. On the ground this pipit walks smartly, nodding its head actively as it walks; but, sometimes, in running rapidly out of the way of a horseman, it jumps over obstructions caused by tufts of grass. Though essentially a ground species, it occasionally perches on slight eminences, such as the wall of a ruined hut. At Somerville, the feathered young have been brought to me on October 26th, but in the neighbourhood of Pirie the earliest nest with eggs was brought in on November 19th. The nest, built in the ground, is constructed externally of rough withered grass, the amount of material and the shape being determined by the nature of the nesting-site. Inside this framework is set the cup proper, of finer grass or of fine roots, with a few goats' hairs or tufts of cows' hairs or even a piece of thread. The eggs, three to five in number, measure on an average 21 x 16 mm. As is usual in the case of pipits, they vary considerably in their markings. The ground colour, greenish-white, creamy-white or greyish, may be sparingly or thickly spotted, streaked or blotched with various shades of brown or purplish-brown.

Cape Wagtail—*Motacilla capensis* L.: The confiding Quacky, as this species is locally called, is an attendant on man throughout our area. In the towns it hunts for its food on the roadways, and delights to parade on the highest roofs, drawing attention to its presence in the heights by its distinctive cry. In the rural districts also it delights to flit about on the roofs of houses and to rest during the mid-day heat in the shade of the buildings. It acquires confidence to enter buildings and march jauntily about the floor at ease, calling to itself all the time; it may even settle on a piece of furniture and trip daintily along over its surface. In the native locations this wagtail wanders about among the kraals and runs over the thatch-roofs in perfect security. Its presence is believed by the kafirs to ensure a well-stocked cattle-

kraal, and no boy who respects the prosperity of his father's cattle would think of throwing his stick at a wagtail. Nowadays, however, the bird is not absolutely immune from the boys; one of my little hunters, in sending in a nest with three eggs, left the message that in my absence from home he had eaten the bird. Away from houses this wagtail is found just as widely distributed. Alongshore, it searches the exposed rocks. By inland water it finds abundance of insect food on the river margins and devours even fair-sized tadpoles. Its call resembles "cheek chee-eek," but a feeble trill, partaking occasionally of the nature of a song, is also frequently uttered. In the latter half of August the wagtails begin building and are busy at nesting-duties till February. The nest may be built by the side of a stream, quite in the wilds; but very often it is hidden among the ivy covering the wall of a house, or it may even be placed under the leaves of a kafir hut. The nest is a loose structure, sometimes of large size, depending for its shape and its support on the cavity in which it is placed. The outer portion, consisting of dry grass, both fine and rough, with small tufts of vegetable material, intermingled with pieces of wool, string, an odd feather and a few leaves, forms a rim round the base of the chosen site and assumes in front a bolder edge, thus creating a convenient hollow for the inner cup or nest proper. This cup is formed of narrow grasses and plant stems, with a few leaves, feathers and bits of rags; and the inner receptacle on which the eggs rest consists of a thick layer of cow's hair, with some wool and feathers. The eggs, three or four in number, measure 22 x 15 mm. The creamy ground colour is thickly overlaid with undefined spots and blotches of pale brown. In 1909 a pair of these wagtails built in a flower-pot outside Miss Dunsmore's* office window at Emgwali Girls' School and afforded that lady the opportunity of determining the incubation-period. The first egg was laid on 17th December, the second on the 19th, the third on the 20th, and the fourth on the 21st. The eggs were hatched on the early morning of January 4th, giving an

* (This lady, subsequently Mrs. Howie, heroically volunteered in her widowhood for the Gold Coast and died there in 1922, a few months after landing).

incubation period of fourteen days. This bird is one of the species chosen by the Red-chested Cuckoo to play the part of foster mother to her young.

Grey-backed Wagtail—*M. longicauda* Rüpp.: This most delicately hued species was first detected in our area by Rickard, who secured one on the Buffalo River, presumably at East London, on 3rd January, 1871. Sharpe refers also to another early record of one shot by Mr. F. A. Barrett near Kingwilliams-town. At present resident pairs of this scarce species occur here and there along the streams emerging from the forest, and at the extreme south of our area a pair has occasionally been seen by Mr. Wood in the Park at East London. These birds love a stretch of river where shallow water flows over flat rocks, and, having once chosen their quarters, they do not wander far from them and are easily found a second time. As they trip along, with white-tipped tails in perpetual motion, they add to the forest-stream an indescribable charm which is enhanced when they mount up among over-reaching trees and flit fairy-like among the branches. Unlike the Cape wagtail, this species never—as far as my experience goes—leaves the river side, but there it displays the same confiding habits as its congeners. One has come within three yards of me as I rested on the rocks in the bed of the Pirie river, and it uttered a note suggestive of a chicken's plaintive call.

African Pied Wagtail—*M. vidua* Sund.: For the first local record of this species we are indebted to Rickard, who procured a male in full plumage at East London on 9th of June, 1870. Nowadays the species occurs regularly at East London during the winter months, June, July and August. They haunt not only the foreshore, but also the road-way, and the precincts of the harbour; they display the typical wagtail characteristics, tripping daintily along in the search for insect food, and often uttering a triple or quadruple note as they walk. The sharply contrasted arrangements of black and white in their plumage shows the affinity of this species to the Pied Wagtail of Britain, and at the same time distinguishes it from the other local species. Our present information does not enable us to determine its true status, but the late Mr. John Wood twice met with it at a time when it might

naturally be supposed to be nesting. On 2nd February, 1909, he saw a pair at the mouth of the Buffalo River and heard the male give a short pleasing song, and again on October 7th, 1911, he saw one on the east bank of the Buffalo. Mr. H. O. Parsons has also met with this species in the neighbourhood of the Buffalo river bridge in the month of February.

Blue-headed Wagtail—*Budytes flavus* (L.): This wagtail is mentioned, in Sharpe's addition of Layard, on the authority of Rickard, as having been once killed near East London.

Golden Oriole—*Oriolus ariolus* (L.): This northern breeding species is an uncertain visitor to our area, occurring about the same time as the European roller. In the local museum are three specimens; one, undated, taken at Kingwilliamstown by D. McPhail, a second obtained at the same place by C. Baines in February, 1906, and a third at Draaibosch by T. A. Newey, on 20th February, 1912.

Black-headed Oriole—*O. larvatus* Licht.: This figures in the early lists of both Rickard at East London, and Trevelyan at Kingwilliamstown, and is at the present day one of our best-known woodland species. Its clear whistle, resounding continually through the forest and the mimosa tracts, captures the attention at once of an observant newcomer; and the brilliant yellow body-plumage—from which is derived the local name of Yellow-Spreuw—set off by the black hood, black primaries and long thrush-like bill, settles the bird's identity. The whistle, more or less prolonged, is a clear "myee-o," used by the pair of birds in answering each other. From its other common call, somewhat resembling "um-ho," is derived the Kafir name of *umro*. In addition to these cries the bird has a triple note "tyah-ho-tyoogh," from which another local name (Tich-tack-toe) is derived. Amidst its various calls I have been unable to determine the song of the species. This oriole lives on insects, fruit and nectar. I have watched one in the thick top of an orange tree darting with some display at insects, apparently bees, coming to the blossoms. In the flowering-season of the red aloe, the oriole clings to the spike and probes its bill into the long corolla tubes for the honey; and, when the flowers of the kafir-boom are laden with nectar, the oriole

joins the throng that gathers to the feast. It generally occurs singly or in pairs, and, from one or two observations I have made, appears to be of a quarrelsome disposition. A nest brought with its owner on 2nd December, 1911, was a swinging cup-shaped cradle suspended by several points of attachment to a branch, and composed almost entirely of a greenish lichen with long wiry stems. The outer portion of the nest was somewhat loose, but the inner compact. Some slender plant stems were inserted between the cup lining and the foundation. The nest measured 89 mm. across the inner diameter of the cup. The two deeply-incubated eggs were of a faint creamy ground colour, spotted and blotched irregularly and sparingly with sepia and with dull steel spots intermingled. On one of the eggs the sepia blotchings ran into scribblings.

Red billed Oxpecker—*Buphagus erythrorhynchus* (Stanl.): Our local museum contains a specimen obtained at the Blue Quarry, Kingwilliamstown, by Peter Smith, on 10th January, 1907. This constitutes the only record from our area.

Wattled Starling—*Creatophora carunculata* (Gm.): A certain historical interest attaches to this species on account of its association with the great locust invasion of 1869, some details of which have been supplied by Dr. Cumming of East London and his brothers. Hordes of locusts invaded Alice, Dr. Cumming's home, and laid their eggs in such numbers that the country later on was black with voetgangers. White Storks and Wattled Starlings came in thousands, and the swarms of the latter wheeling about would, in passing, sometimes almost obscure the sun. Occasionally, when they passed the single telegraph wire, a number of these starlings would be killed or maimed by striking the wire in their rapid flight. Hundreds of Wattled Starlings built nests in the thorn trees along the Tyumie below Alice. The "nests" were as large as those of the Hammerhead, but, instead of being single nests, they were huge conglomerations of separate nests and were in some cases so heavy that they broke the supporting branches. The youthful bird-nesters of Alice had the time of their lives and came home at nights with long strings of blown eggs. Dr. Cumming's father, together with some other gentlemen, represented the matter to the magistrate and orders were issued that

the birds were not to be further molested. Rickard is no doubt referring to the same invasion in his remarks on the Wattled Starling. "An immense flock arrived at East London; in a few days they broke up into smaller flocks and associated with *Amydrus morio*. They were feeding on the locusts which they took on the wing like a flycatcher, flying up a short distance, and returning to the same resting-place. The ground beneath the bushes on which they rested was strewn with the legs and wings of the insects." Curiously enough, in the great locust invasion of 1909, nothing whatever of locust-birds dealing with the invaders was seen in our area; nests of Wattled Starlings, however, were reported from Emgwali in the summer of 1909-10. In the river-basins of the Buffalo and the Keiskama, Wattled Starlings may generally be found in small numbers about the mimosa tracts, where I have noted them in April, May, August, September and November. Our local individuals have nowadays few opportunities of gorging on locusts, and have to be content with scouring the country in search of other prey. They associate with Pied Starlings and Red-winged Starlings and may occasionally join these rogues in visiting a fruit-garden, but, as a rule, they keep far enough away from orchards and are content to prey on the abundance of insect-life on the veld. Like other starlings, they are fond of associating with sheep and cattle, and I have watched one settle down deliberately to feed in the shadow of a cow.

Pied Starling—*Spreo bicolor* (Gm.): This bird is unaccountably scarce in our area. On 27th August, 1912, I met with a number among the mimosa between Pirie and Kingwilliamstown, and again on 20th June, 1915, I came on five to the east of Pirie. These are my only personal records, and no others are known to me. Rickard plainly stated that the bird was not found at East London in his day, and neither Center nor Wood record it at the present day. Trevelyan also is silent regarding its occurrence at Kingwilliamstown. Yet the bird is common enough just beyond our limits. Mr. Wood informed me that there was a good colony on the banks of the Kubusie, at Waterford, but that in 1905 nearly the whole colony perished in their roosting-holes during a disastrous flood. At Somerville, Tsolo, the Pied Starling is resident but erratic in its movements. For

several months a party came nightly to roost beside the Lesser Kestrels in a gum-tree and would often noisily call, late at night and at early dawn. Their alarm was so contagious that at the utterance of the sharp, single note, the whole flock of over a hundred kestrels would dash out of the tree in wild concern. Sometimes, in coming to roost, the starlings played around for some time before settling, and a pair would occasionally separate from the others and rise perpendicularly in the air, then shortly afterwards subside again into the general swing of the company. They left their roosting-place at the first streak of dawn.

Mr. O. Brigg, in describing the habits of this species at his farm on the Herschel border, tells me that at sunset thousands came to roost in a poplar copse near his house. They kept up their noisy notes till darkness set in, and, if disturbed at night, they would rise with a noise like distant thunder. For the greater part of the year they seek their food on the ground and may often be seen hobnobbing with the cattle; when feeding where sheep are pasturing, they perch readily enough on the backs of the sheep. In autumn, they gather in flocks in the fields of kafir-corn and mealies, and levy tribute from the standing grain, and in the month of July they love to feed on the red aloe.

On the 18th October, 1917, my wife and I noticed a Pied Starling on the edge of a donga near our house at Somerville. As we had seen a pair at the same spot some weeks previously, we suspected the presence of the nest, and I went down into the donga and soon found a likely hole, running with a slight upward trend into the bank. The diameter of the hole narrowed rapidly from just over five inches at the entrance to three and a third inches. Inserting a wand to test the depth of the hole, I withdrew along with it feathers and wool. This clear proof of occupation was confirmed by a harsh scream from the owner dashing past me. Inserting my arm I could just reach the eggs, four in number. The nest, which occupied a shallow depression about a foot and a half from the entrance was a rude conglomeration of material; mixed with and overlying the foundation of vegetable matter—both fine and rough—was a mass of feathers (chiefly the smaller feathers of fowls and the feathers of a dove) with goat's hair, wool, paper,

pieces of rags and the slough of a snake. A second time the owner approached with the same wild shriek, but finally left me and joined her mate in a tree. To my surprise the eggs, though somewhat soiled, were quite fresh. They measured 29.5-32 mm. x 21, and were bright greenish blue, more or less thickly covered at the larger end and much more sparingly elsewhere with dull ashy spots. Both the extent of the spotting and the size of the spots varied considerably.

The kafir name of this species, "igiyogiyo," is an attempt to render the call so continuously uttered in flight.

Black-bellied Glossy Starling—*Lamprocolius melanogaster* (Sw.): This species appears in both of our early lists, that of Rickard at East London and of Trevelyan at Kingwilliamstown. In the winter months, this species occurs nowadays in flocks of considerable size in the neighbourhood of East London, and of late years has been seen by Mr. John Wood in mid-summer also. On 27th February, 1918, Mr. Wood and I came on a pair feeding in the top of a tree at a densely overgrown portion of the Buffalo banks; they kept uttering a very rough cry for some time before they decamped. Although the nest has not yet been obtained there can be little doubt that the birds are now established as a nesting-species at East London. In the upper portion of our area the species is still rare, though a specimen obtained at Kei Road by Miss E. Hudson in February, 1906, is in our local museum.

Red-shouldered Glossy Starling—*L. phoenicopterus* (Sw.): This resident species generally occurs in small parties of from six to ten individuals, that attract notice by the distinct swishing of their wings in flight and by their dazzling metallic plumage. These birds are specially common about the mimosa scrub and along the borders of the forest, but they frequent mealie gardens also and, with a great display of affected shyness, hang about houses as well. They are omnivorous, hunting usually on the ground for grasshoppers and other insects and often feeding close to the feet of goats or horses; in the fruit season, however, they indulge largely in wild berries, suck the nectar of the kafir-boom and visit the cabbage-tree, and, where they possibly can,

claim a share of our grapes and our figs. But, on account of their beauty and their general usefulness, we do not grudge them a small share of our orchard-produce. Even where they are never interfered with, these birds display an unconquerable shyness. They come to the house night by night, yet are always ready to decamp from imaginary dangers, being in this respect the very antithesis of the Red-winged Starling. The late Mrs. Young, of Main Mission, Tembuland, reared three of these starlings and released them. By systematically laying down food for them she induced them to remain about the house. They brought other six of their kind to share in the hospitality so generously given; and, at the time of my visit to Main, five birds were frequenting the bread-table,—a barrel placed underneath a tree. Beautiful birds they were, with their metallic green gloss and their orange eye. The Red-winged Starling had discovered the table too, and at dawn would come fearlessly to eat his fill. He knew well enough that he was not wanted, and later in the day he was more circumspect, but he was still bold enough to enter the dangerous region. After putting down fresh food, Mrs. Young would stand near the table to inspire dread into the Red-wings; and these latter birds, fully understanding her purpose and being unable for the time being to share in the food, did their best to prevent the Glossy Starlings from eating. Yet there were five of the latter and only two of the Red-wings. A Glossy Starling would descend to the table and begin eating, and a second by short flights would also eventually reach the table. When the two were settled, down would swoop a Red-wing and scatter the favoured birds amid shrieking. This little comedy was enacted over and over again.

These starlings sing all the year round, and are specially musical at early morn and after sunset. For the greater part of the year, the male pours forth his notes from a certain favoured spot. When there is as yet a mere glimmer of light in the sky, he begins his matins, and for twenty minutes or so maintains his loud notes; then with heavy swishing of his wings he sets out for business. Usually, we hear no more of him till night; but, just before the darkness descends, he strikes up his vespers.

at the old stance and continues for another twenty minutes before going to roost. Should a storm of rain come on in the late afternoon, he will make for his singing-quarters and sing his loudest during the storm, and later strike up again at his normal time. During the mid-winter months he often settles down in a bush in the heat of the day and croons away in pleasing strains to himself. The Glossy Starling nests in holes of trees or of buildings, and shows great pertinacity in clinging to a chosen nesting haunt. Mr. Fred Madlingozi tells me that at one particular hole five of these birds were caught in succession, but that the hole was not deserted by the species till the tree was cut down by the owner of the field. On 17th December, 1909, a bird with five incubated eggs was brought to me from a hole in a tree at Pirie. The eggs, measuring 28-30 x 20-21 mm., are bluish-green in ground colour, sparingly spotted and dotted with brown and violet. Two brood are reared in a season.

Red-winged Starding—*Amydrus morio* (L.): This is the most abundant and best-known of our local starlings. Originally a bird of the cliffs, it still frequents such situations both along shore and inland, and in such places its pleasing musical call, re-echoing from the rocks, has, especially at sunset, a bewitching charm. Like several other cliff-birds, however, this starling takes readily to buildings, and, from its pertinacity in clinging to its chosen haunt, it becomes at times an actual nuisance. Through broken panes or ventilators they gain access to unoccupied buildings; occasionally one fails to re-discover the place of ingress and dies of starvation in its prison. A pair cling to the Pirie church, and often, when the church is lit up at night, one or both flutter about the building in wild alarm, but they do not for this occasional inconvenience desert their home. In November, 1908, they actually built on an open buttress inside the building. I had no intention of allowing them to settle there, and on the 10th I removed the still unfinished structure; it was a huge mass of mud with rough plant stems and measured in its foundation eleven inches by eight. For a time I thought the birds, having been thus foiled, had given up their intention of nesting in the church, but, on the 16th February following I reard the ominous squeal-

ing of young birds under the roof and I knew that the red-wings had defied me after all. In 1910 they chose another site under the roof, and are probably maintaining their hold in the building to this day. From long-continued observation I believe that the nesting-birds remain, in certain cases at least, all the year round at their chosen haunt, but in winter great flocks of these birds gather at suitable feeding-places and may remain in flocks for a lengthened period. Flocking begins on a small scale at the beginning of March and reaches its climax in the spring months. In 1909, during September, October and November, as my correspondents, Messrs. Weir and John Ross, informed me, hundreds of Red-winged Starlings frequented King-williamstown and roosted nightly in the graveyard and elsewhere.

Belonging as it does to a noisy tribe, the Red-winged Starling is ever proclaiming its presence by its whistling call *hi-yoo*, uttering it repeatedly and lengthening it out at frequent intervals into a more pronounced drawl. The alarm is a harsh guttural lengthened sound, resembling the *ra* sound in *kafir*. Noisy though the bird is, however, it swoops into its roosting-place under a verandah in perfect silence as a rule. At Somerville, one used to roost in the full glare of my study-lamp; on rare occasions it uttered its call, but usually it swooped into its place suddenly and silently, though the slight noise made in alighting was sufficient to attract my attention. During heavy storms it sometimes called in the darkness. Like the European Starling, this species settles on the backs of sheep, but not nearly to such an extent as its northern ally. It is a great fruit-eater, feeding on the berries of the wild currant and the jessamine, the fruit of the cabbage tree, the nectar of aloes and blue gums, and coming to our gardens to take toll of grapes, apples, figs and other fruit. The bird generally settles down leisurely at the fruit it is eating, but it may view the berry it covets from a distance, fly towards it, and, plucking it off in flight, pass on with it to another perch. When the flying termites emerge, the redwings join in the throng of birds that gather to the spoil, and fly up into the air and catch them on the wing; they also devour such larger fry as grasshoppers. Nesting lasts from the latter half of September to the

end of April; at Pirie on September 27th, I watched a pair vainly trying to lay the foundation of a nest on the elbow joint of a down-pipe at the school; when the rain washed away their structure they found out their folly and they gave up further work there. The birds often build on ledges outside or inside of buildings, or may choose a box set up for pigeons, but they prefer a hole as their nesting site. On a ledge they build a large foundation of mud, twigs and plant stems; but in a hole, where no such support is necessary they content themselves with constructing a cup of slender grass, lined with the very finest strands or with hair. Those nests examined by myself have either been empty or had young. At least two broods are reared in the season, and Mr. Wood has found the young still in the nest, though just ready to fly, as late as April 27th. The adults are very bold in the defence of their young, and, even under a verandah where they are receiving sanctuary, they swoop down with their harsh guttural alarm at the heads of their protectors. The young, on acquiring the power of flight, leave the nesting site, but the adult pair remain. On 16th June, 1912, the female of the Pirie church pair was caught in the church and put in a wire enclosure with a rock-dove that had also been caught in the church. Throughout the next day the male redwing haunted his mate's prison, sitting often on the top of the wire netting.

Some Nesting Habits of the Cape Robin.

By H. G. EATON.

This year a pair of Cape robins conducted house-keeping operations in my garden. At one side of the garden, about forty feet from the stoep, is a rustic summer house with an equally rustic flower stand at the back of it, here among the dried fronds of a fern the robins built their nest. The earlier operations I did not see being confined to the house through illness, and when convalescence made observation from the stoep possible, the young birds were on the high road towards fledging. Unfortunately the observations only lasted a week owing to the intrusion of a rival observer whose ornithological interests were solely gustatory.

The feeding of the young was carried on by both parent birds, but the method of approaching and leaving the nest was markedly different. The male flew to a cross pole of the summer house, took a quick look round and dived straight down to the nest. He left it in the same way apparently without much thought for concealment. The female on the other hand was most furtive. She flew first of all to a near by rose arch, then to the top or side of the summer house, then to the lower shelf of the flower stand at the end remote from the nest. From this spot she darted to the nest keeping behind the flower pots. She followed the same route on leaving. Her looks round were not at all perfunctory; they took anything from a quarter to half a minute. She varied this approach sometimes by dropping down through the branches of a tree forming one corner of the summer house, and flitting through the ferns. Her extreme caution was amusing and, in view of the rival investigator, pathetic.

About three yards from where I was sitting there was a patch of dry sandy dust. I noticed that both birds brought the grubs or worms to this patch and deliberately rolled them in

the dust until they were gritted all over before carrying them to the nest. This was not done regularly, about four or five times during the day perhaps, but they may have had another dust patch somewhere else.

The sanitary arrangements were left in the hands, or rather beak, of the female. The droppings were not just dumped over the side of the nest to be an advertisement to every passer by; they were carried away to the far side of the garden, but by the female only—a habit on all fours perhaps with her furtive approach to the nest and the male bird's dashing, careless-of-consequences methods.

Stray Nature Notes.

By F. J. LAWRENCE.

I have written to the Rev. R. Godfrey asking him how it is that the sweet continuous song of the white-eye is not referred to by any writer on the birds of South Africa. He replied and asked me which of the two was the song bird, the green white-eye (*Zosterops virens*) or the Cape white-eye (*Zosterops capensis*). I believe that I have heard both and only the male when isolated from the group. I am still waiting my opportunity to observe the singer. In the karroo just behind my office the bird was very frequently heard in some large pepper trees (*Molle schinus*) and I often called the attention of my friends to his song. In Aliwal I do not see these little friends so often.

The white bellied swift (*Cypselus africanus*) arrived in the town of Aliwal on the 18th of August. Sclater writes of it as found in all mountainous districts. I have found it in the plains of the karroo twenty miles from any mountains. In Aliwal these swifts have been very troublesome round bee-hives and in one instance were not driven off until several of their number had been shot.

The wattled starling or kaalkop spreeuw (*Dilophus carunculatus*) appeared in my garden on the 21st of August—a little group of fourteen comprising one or two young male birds with undeveloped combs and wattles. They were in the company of some pied starlings (*Spreo bicolor*) which, with the amethyst starling (*Pholidauges leucogaster verreauxi*), has lately been introduced to the visitors of the London Zoo, both according to the "Field" (March 12th, 1921,) for the first time.

The willow wren (*Phylloscopus trochilus*) arrives in Aliwal in October and leaves early in March. All day long its clear note is heard from some thick shrubbery. It sings almost incessantly in its joyous way. At times, however, the song is so insistent that it would seem as if, while enjoying the rhapsody, some too

serious purpose was somewhere in the back of the male's head. These wrens, together with swallows, martins and other birds have been very rare in Britain this summer. Intentional electrocution and other methods of slaughter for the market, on the increase in the south of France and particularly in Italy, the half way house of migration, are given as the chief causes.

I saw the spotted flycatcher (*Muscicapa grisola*) for a few weeks in February and March (1921) darting from some tall pole and returning with his catch.

The didric or golden cuckoo (*Chrysococcyx cupreus*) is here and in Jamestown from November to March with his melancholy call. Starting from a topmost dead branch of the wild willow or other large tree it will make for a similar footing further on, calling as it flies, then on to another rest and back to its first starting place. I have watched it keeping to this triangle of perches, delaying a good deal and calling repeatedly at each point. Possibly the foster mother is in the neighbourhood doing duty by the cuckoo's eggs and the cuckoo is showing just this interest in her offspring.

Territorialism and "Sexual Selection."

By A. H. HAMER.

Anyone who tries to keep a number of birds together without regard to species, even in a large aviary, will soon find he is in for trouble. He will find it impossible to keep more than one male of certain species at any time of the year and at breeding seasons more species will develop the same fault. There will have to be a process of elimination and certain "pugnacious little brutes" will have to be taken out. What will have happened when peace is restored is that he will have eliminated or reduced to one male each of the territorial species and his main stock will consist of non-territorials. This seems simple enough, but the matter is seldom referred to in a manner which seems to show a true appreciation of the problem. Certain species are dubbed "pugnacious" and it seems to be supposed that they revel in fighting for fighting's sake. There is no fighting for fighting's sake in Nature, however, and much less fighting of any sort than is popularly supposed. The male sun-birds, say, which you have included in your aviary, fight because their instinct compels each to try to keep a certain radius of territory clear of other mature males of the same species. The fighting will be ultimately disastrous to the weaker in the aviary, if they are not removed, simply because they are artificially prevented from accepting the logic of facts and clearing out. In a state of nature the inter-loper would retire at the first dash of the rightful owner and there would not be a set battle to decide which was the stronger, neither would the bird in possession pursue the other beyond his radius for the sake of a fight. A fairer and better description of his character is therefore "territorial," rather than "pugnacious."

That Nature desires to minimise real fighting is seen by the immense proportion of disputes which are settled orally, so to speak, or by a display of threatening attitude re-inforced perhaps by special devices such as crests or inflations (A).

A familiar and easily observed territorial bird is the robin, Cape or British. He is a strict territorial, apparently, all the year round, yet though I have often seen him dash at an intruder I have never seen the introducer resist so that a set fight ensued, and on the whole what a peaceable life Jan Frederic lives. He sings his proclamatory song night and morning, curses the cat from bush to bush when there is a family, but I have observed little if any interruption of business by interlopers. The appearance of territorial birds proclaims the same thing, neither Jan Frederic or your smart coloured sunbird are battered or dishevelled in the process of keeping their territories intact. As a matter of fact they probably have not a feather awry. If then we may assume, as both observation and common sense seem to tell us, that nature has no use for fighting, we can understand the adoption of various devices for reconciling the necessity of territorialism with as little destructive fighting as possible. The song of birds has been recognised as such a device, then why not colour? On this view the red on the robin's breast is a warning colour which catching the eye of a trespasser saves further trouble by informing him that the territory is occupied(B).

All the difficulties attending the theory of sexual selection need not be recapitulated here, but one of them concerns us *i.e.* it is not the beauty or strength of the male which is the deciding factor at the critical moment but simple propinquity. In other words in Nature when internal conditions cause the female to desire the male the first male to seize the opportunity is accepted, and this holds good even in the case of birds which are paired.

It is obvious therefore that apart from the question of food supply the bird whether polygamous or monogamous which keeps its territorial well clear of hangers on will leave most of its own progeny. In other words the purposes fulfilled by territorialism are one or both of the following, (1) the conservation of a food supply, (2) the jealous reservation of the female partner or partners. If it is expedient that this should be done with as little interruption of life's business by fighting as possible, then the development of brilliant colours in male territorial birds can be

understood. If I am asked why the would-be trespasser or inter-loper should take heed of the warning song, colour or display; my answer is, observation shews that the morale bestowed upon the possessor by settled possession of territory appears among birds to be irresistible. The turkey-cock's display is palpably of a warning and threatening nature, and has no apparent influence on the hens. There does not seem to be any difficulty in interpreting the display of other birds in the same way. It is nothing out of Nature's way if displays are also induced by excitement in the presence of a mate. In my observation such displays are chiefly induced in the excitement of first meeting a mate, a circumstance which would naturally stimulate the territorial instinct.

Real communication between the sexes is by quite different methods, *i.e.* by soft sounds and endearments to which both respond, and these are sympathetically recognised by ourselves for what they are without any doubt.

On our theory, then, the tails of the peacock and the argus pheasant are their respective territorial banners; the brilliance of the former has been developed by natural, not sexual, selection in relation to its natural surroundings, and the "eye pattern" is one excellently adapted for catching the eye of an intruder.

Another difficulty of sexual selection is stated as follows: "Sexual choice certainly cannot account for the remarkable ornamental colours of the males of many fishes in the breeding season, for in many cases the female may not even see the male which fertilizes her already laid eggs. Eigenmann on the other hand, notes the utter absence of such ornamentation among cave fishes which live in the dark, and argues that where they do appear, therefore, they must be due to visual selection." (Lull. 1917. p. 122). If these fishes are territorial as *e.g.* the stickleback, our theory solves this difficulty. (C).

We may now glance at some familiar examples of non-territorial birds. Such are rock-doves, starlings, rooks, jackdaws, our Cape weaver bird, and the sparrow. All except the last are birds of strong flight, which is obviously necessary when a number radiate from one centre at nesting time. They have no vivid warning colours. In each case the adoption of nesting sites in

common, instead of isolated castles, as it were, is correlated with the adoption of special sites, which are naturally more or less scarce. The weaver bird wants a tree overhanging a deep pool of water (D). The pied starlings a piece of cliff-like, but not too hard, river bank, the jackdaws a cliff or church tower and so on.

Once after riding all over several adjacent farms I came at dusk to a place where there was a bend of a stream against rising ground; a small krantz with a shallow cave. As we passed, a little cloud of rock pigeons flew out. It was their only suitable refuge in all the country we had traversed and the reason of the development of strong flight and the homing instinct in such pigeons was impressed on one in a flash.

It must be noted that our non-territorial examples, though not vividly coloured, have their patterns and markings, some of which are developed in the breeding season. In the male of the English starling, for instance, the beak becomes of a colour very like the evening primrose. This may be explained by what we may perhaps call "limited territorialism," as such a colour would be easily seen by a trespasser in a dark hole.

In the same way I should explain the iridescence on the pigeon's neck and his habit of puffing out the crop. His display, in which he coos and wheels and runs round his mate, I should describe as a very natural way of proclaiming her his property amongst a crowd.

Both territorials and non-territorials use their voices but if we take the thrush or nightingale as the type of the plain-coloured territorial which proclaims itself by song we see at once there is a type of song that we may call "proclamatory;" we also observe that the producers of this type of song constantly repair to some point of vantage from which to deliver it, usually at dawn and near sunset (E).

This presents a contrast to the chatter or chattering songs of jackdaws, starlings and weaver birds.

Our theory in no way bars the probability that both sound and colour stimulate the joy of life in birds as most things in Nature are put to more than one purpose. The voice in birds is certainly used to express many simple emotions and responsive communica-

tion of pleasure is often unmistakable. In my own view the "chattering" type of song is simply a stimulus and expression of joy and the proclamatory type has been developed for the special purpose of territorial warning. It is chiefly characteristic of soberly coloured territorial birds in situations where conspicuous colouring would be out of accord with the surroundings. In seed-eaters the song no doubt is both an expression of pleasure and a serviceable adjunct of what I have called "limited" territorialism, *i.e.* care of the nest and perhaps immediate surroundings. Birds in an aviary are certainly very prone to pull each other's nests to pieces for the sake of the material, and it is clear that among birds of the same species the temptation to rob must be great.

Examples of other devices for territorial warning such as the bird flying over its preserve shaking long plumes or clapping its wings will occur to everybody. My suggestion is that all these things have been developed by natural selection for that purpose, and not by sexual selection.

- (A) As, for instance the cock ostrich which "rolls from side to side with wings outspread, then stalks majestically as if he meant business." (F.H.H.) 1.
- (B) and "so are the white wings of the ostrich which he often waves about whilst parading round his territorial ground that onlookers in adjacent camps may have a care." (F.H.H.).
- (C) In this connection the observation by Mr. Arthur Reid in this Journal (Vol. II. No. 2, pp. 261-263) is interesting. Speaking of the spawning of the brown trout he says: "During these days the fish jealously guard their deposit, the cock fish chasing away any other that may be approaching his preserve." Again, speaking of the rainbow trout, "the beautiful red lateral rays increase in brilliancy as the spawning season approaches."

¹Mr. Fred Holland of Despatch who has kindly given me some useful notes, particularly his first-hand observations of the ostrich.

- (D) Weavers often build in a tree away from water, near grain fields from choice. (F.H.H.).
- (E) or after sunset as our Cape robin does. (F.H.H.).

Addendum.

Since writing the above I have had the pleasure of reading Mr. Howard's "Territory in Bird Life" in which the idea of territorialism is worked out in detail.

There can be no doubt that territory plays a great part throughout animate nature and territorialism must have a great influence on the psychology of animals, including man.

The point I wish to suggest is that colour in birds (also no doubt in fishes and other animals) as well as song is an adjunct of territorialism and I may summarise as follows: —

1. Territorialism may be assumed.
2. Fights "a outrance" in nature occur seldom. The animal feeling itself subject to superior moral or physical weight usually retires and, besides this, Nature encourages the settlement of disputes by bluff, and the assertion of morale orally and by attitudinising. The closest tussles occur during the re-settlement of territorials before a breeding season when neither combatant has attained the morale bestowed by possession.

Observation tells us that a bird rearing its young on a defended territory is left more or less at peace, that such intruders of its own species as appear are driven off easily by the morale of the "man in possession." Common sense tells us that constant fighting would interfere too much with the business in life of the animal and defeat the ends of territorialism.

3. It has already been suggested that one of the uses of song in birds is to warn off trespassers from the territory and I now suggest that colour and plumes serve the same function. The red on a robin's breast is admirably adapted to catch the eye as he moves through the bush. The sugar bird flies over his territory shaking the plumes of his tail. The ostrich parades his boundaries waving the white plumes of his wings.

4. Selection would act from the fact that by such degrees as the territory is kept clear without actual fighting so would the young be more efficiently raised.

Notes on Some South African Tadpoles.

By JOHN HEWITT.

That the fauna of South Africa is exceedingly rich and varied is a well-known fact. Collectors of butterflies tell us that only 55 species are to be obtained in England, of which some are very rare, and that only 16 species occur in the Islands of New Zealand, whereas without great difficulty about 100 species can be obtained in the immediate neighbourhood of Grahamstown. And, so it is with many other groups of animals.

Yet, having regard to the amount of arid or semi-desert country in South Africa, few biologists would have expected to find so large a fauna of frogs and toads as occurs in this sub continent. In the whole of Europe only 20 species are known, whereas at least 50 species occur in S. Africa, and still a few await discovery. One of our toads, the common Plathander, (*Xenopus laevis*) has been described from its egg stage upward by various authorities, but apart from a few notes by the present writer and J. H. Power, practically nothing has been written on the breeding habits and early stages of the other S. African species. Here is an untouched field for the naturalist observer.

Although these animals are essentially amphibious, and generally quite dependent at one stage of their life on freshwater pools or streams, some of our toads are sufficiently acclimatised to thrive in the midst of very arid districts. Dr. Brown tells me that a kind of *Breviceps* (popularly called Blas-op Jan Blom or Donderpadde) occurs at Port Nolloth where no surface water can be found within 50 miles. The toads of this genus with tensely swollen bodies and abbreviated limbs are known from various parts of South Africa, but never, so far as I can ascertain, from pools or rivers, nor from the neighbourhood thereof. They positively abhor water, and it now seems to me very probable that *Breviceps* will prove to be quite independent thereof, and de-

void of the swimming tadpole stage. Its eggs will be found, I think, hidden deep in the ground, perhaps in a termite mound. We know, at any rate, that in other parts of the world a few frogs and toads have abbreviated their life histories to the extent of completely omitting the tadpole stage, but until recent years no such case has been brought to light in Africa. The Jan Blom resembles the species above-mentioned in possessing eggs distinctly larger than those of an ordinary frog and, moreover, comparatively few. In an adult female example from Grahams-town I counted only about 30 eggs excluding very minute ones, whereas those of most frogs and toads number many thousands. The thousands of small eggs that successfully serve the maintenance of a race in a normal environment may be less likely to survive the perils of a waterless country than a few large ones that rapidly transform into active little frogs.

Nevertheless, the omission of the tadpole stage is not a usual phenomenon amongst the frogs and toads that inhabit the arid districts of South Africa. The several species that occur commonly in the Karroo (*Rana* and *Bufo*) certainly pass through a tadpole stage. However, the metamorphosis of an average karroo species, although probably just as complete as that of any other frog, seems to be passed more rapidly than is the case amongst its relatives in better water regions. According to Mr. J. H. Power, the little toad *Bufo vertebralis*, that breeds in muddy pools near Kimberley and Victoria West, passes through the whole of its metamorphosis, from the laying of the eggs to the time when the young toad jumps out into the world in sixteen days. These are no statistics relating to the metamorphosis of other species of *Bufo* in S. Africa, but it is of interest to note that the corresponding figures for the European species are 8-12 weeks for *Bufo vulgaris*, 2 months for *B. viridis* and 5-8 weeks for the natterjack, *B. calamita*.

A few years ago, Dr. Geo. Rattray discovered a remarkable instance of simplified life history in a frog that lives on the Amatola range near Hogsback. This little creature has the habit of laying its eggs in a small chamber just beneath the surface

of the ground. Within the chamber, the eggs undergo the whole of their development, moderately damp and cool yet without water. No swimming tadpoles emerge therefrom, but the embryos that wriggle their long tails within a capsule of transparent jelly may fairly be regarded as incipient tadpoles. Dr. Rattray's report is as follows:— "We hunted for long days for the tadpoles you wanted (*Heleophryne*) without success, but I found the nests of a frog. They were spherical, about an inch in diameter, just under the surface of the ground and contained about 20 eggs. The whole cycle of development must be completed in the nest. The Hogsback hotel is situated on a narrow plateau at the top of the Tyumie Valley, and my aneroid gave the height at 3,600 ft. The southern top of this plateau is bounded by the steep, forest-clad slope which descends rapidly to the Tyumie valley. It was in the depths of this forest that I found the nests. Three of them occurred on bare patches of ground, but the rest were among a sparsely growing forest grass. They were just as far away from water as was possible in a locality abounding with shrams, for those I found were on a slight watershed between two shrams." Writing again in January, 1919, at a time of widespread drought, Dr. Rattray reported: "Nests were not so easily found as last year and it is evident that this toad required a certain degree of moisture, for even the comparative drought which Hogsback has been undergoing plainly destroyed many broods. I could find no newly deposited eggs, but found one or two nests with frogs in almost the adult form. I tried a few crude experiments of transferring the embryos to water in the hope of upsetting the normal development and making it revert to that of the order but only succeeded in drowning the specimens."

This little frog, at that time new to science, was described by the writer under the name of *Anhydrophryne rattrayi*. Rattray's frog belongs to the family *Ranidae*, including the common water-frogs, and is not directly related to those frogs in tropical America, of the family *Cystignathidae*, which omit their tadpole stage in a similar way. Thus, it would seem that frogs belonging to different families and living in different regions have in-

dependently evolved the same peculiar mode of development: or, on the other hand, it is possible that this mode of development is actually the primitive one and the swimming tadpole stage quite secondary. If the free swimming tadpole stage is actually a primitive feature in frog development, as most zoologists assume, it seems strange that the omission should take place in a region so well watered as our forests. But the answer to this question can best be derived from a detailed study of the embryology, which is about to be carried out by Dr. E. Warren.

Various other species in S. Africa depart more or less from the usual course of development in frogs as exemplified in the genus *Rana*. Boneberg's frog, originally described by the writer and P. A. Methuen, from Marianhill, Natal, has a true tadpole stage, but the eggs are not actually deposited in water. The clusters of spawn are either attached to exposed rocks from 2-6 feet above the surface of the water or to the branches of overhanging trees. Apparently, the eggs hatch into larvae which wriggle about in the slimy mass and eventually fall into the water below, or are washed therein by rains. The home of this frog is bushland country in shady rivulets overgrown with creepers and thorns, the water therein being actually very scanty though flowing all the year round.

Another Natal species, *Megalixalus spinifrons*, also lays its eggs on the leaves of trees, according to Fr. P. Boneberg, and a large species found in the low veld districts of the Transvaal behaves in a similar way. The latter (*Chiromantis xerampelina*) is even reported to watch over its developing young, showing solicitude for their welfare most unusual amongst creatures so lowly. According to information received some years ago from Mrs. H. Streeter, the facts are as follows :—

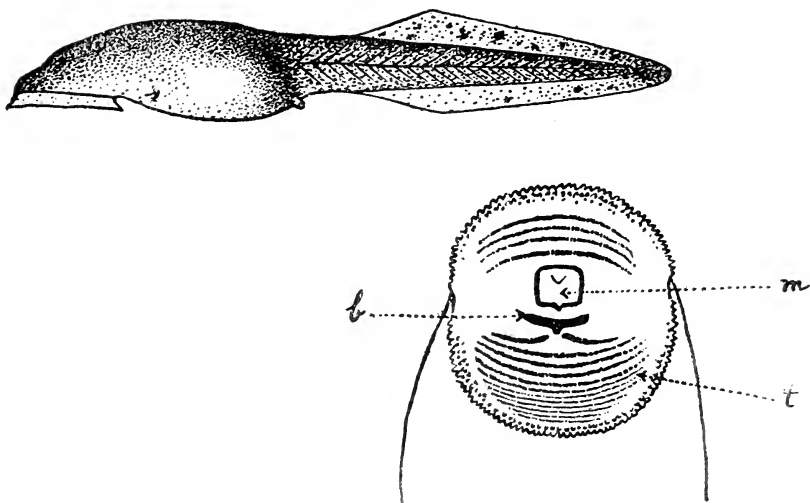
The female frog deposits a large ball of foam in which the eggs are placed. This is always above a waterhole whence the frog obtains water to keep the foam moist by squirting liquid thereon at intervals. If the frog is killed or the water dries up, the ball becomes hard on the outside like gum or glue and the contents perish. It is then occupied by a large fly, apparently

attracted by the smell of the dead tadpoles or the eggs, and many people seeing the flies issuing from the ball think it was deposited by them.

Referring to this species, Mr. R. H. Harris, now stationed at Cogweni Camp in Northern Zululand, writes:— "While in the bush yesterday (Nov., 21st), I came upon a pond and noticed, attached to the trees bordering it, large masses of spume. Thinking it might be cercopids, I collected one lump and found inside it some thousands of cream coloured eggs and many tadpoles. The outside of the masses was firm and dry, while inside was considerable moisture resembling the spume one sees at times on the sea shore. The masses were as large as cocoanuts, attached to the branches sometimes as much as eight or nine feet above ground, and overhanging the water."

A very curious tadpole (*Heleophryne*) was found a few years ago by Rev. P. Boneberg in Krantzkloof, Natal, the mouth of this creature is modified into a large circular sucker, by means of which the tadpole attaches itself firmly to the rocks in the river beds. Living specimens when handled are apt to cause great consternation by sticking like leeches to the hand of the captor. Their home is a stream, strewn with boulders, and interrupted by several falls and cascades in the valley of the Krantzkloof; there, in virgin forest at an elevation of about 1,500 ft. the heleophrynes revel in little pools, browsing on rocks especially where the water flows freely. Their parents probably live in trees but nothing whatever is known of their habits, and the only specimen in any collection is the juvenile example reared from a tadpole by Boneberg from which the species was described.

The sucking habit would seem to be an adaptation to life in mountain streams enabling the creature to enter its home even when the streams are scoured by violent torrents of water. Such an adaptation had not previously been known amongst African toads but I have since learnt from two independent sources, Mr. K. H. Barnard and Mr. J. H. Power, that similar tadpoles occur on the mountains not far from Capetown. It is noteworthy that tadpoles with large suckers around the mouth occur also



Tadpole of *Heleophryne natalensis* H. W. H., and enlarged view of sucker. (m, the mouth aperture; t, rows of minute horny teeth; b, beak formed by fusion of horny teeth.)

in the mountain streams of Borneo and of the Himalayas, but they are not directly related to ours, and moreover the suckers are built on a different plan. It is quite evident that the adaptation has been independently evolved in these several instances.

The above scanty notes should at any rate indicate how little is actually known of the life histories of the S. African frogs and toads and perhaps also how quaintly interesting such studies may be.



The Production of Sound in a South African Locustid
Acanthoplus bechuanus Per.

By R. BIGALKE, M.A.

In South Africa there occurs a number of species of large, almost wingless locustids known as korenkrieks; such a korenkriek (*A. bechuanus* Per.) is common at Glen, O.F.S., during the months of April and May, and can be found in long grass, on acacia bushes, or on cypress trees. During June these insects were observed to become less common, and later to disappear altogether. From the dead and benumbed specimens obtained at this time it was concluded that they were killed off by the frosty weather.

Both male and female are stoutly built, and each has a large spiny shield-like pronotum which projects backwards and extends over the mesonotum and metanotum. In the adult male the metathoracic wings are absent, and the tegmina are very much reduced in size. In other locustids, such as for example *Microcentrum*, the tegmina are well developed and veined, and, in addition to being provided with a stridulating apparatus, they protect the hind wings, the organs of flight. In *A. bechuanus* the sole function of the much reduced tegmina is that of producing a shrill sound; this can be kept up for a long time, and may be heard during the greater part of the day when these insects are common; it has also been noticed on moonlight and other evenings. Since these tegmina are very much reduced in size and subserve one function only in the male, that of stridulation, it seems justifiable to designate them with a special name, and the term *tonotegmen* (*L. tonus* = sound or tone) is suggested.

The adult female has vestiges of tegmina much smaller than those of the male; there is one in the form of a very small flap along each side of the mesonotum, and they are separated by a considerable space, neither showing any trace of a stridulating

apparatus such as is found in the male. In the immature male, about half-grown, the tonotegmina resemble the vestigial tegmina of the female in that they do not overlap, but are separated by a space in the middle line; they are larger than those of the female and are of a soft texture.

Left tonotegmen of male:—This is strong, chitinous, and somewhat rectangular in shape. Towards the anterior margin along the ventral surface and situated transversely, there is a file-like organ consisting of about 25 chitinous teeth next to each other and raised in position; the position of the file is indicated on the dorsal surface of the tonotegmen by a well-marked groove. The tonotegmen shows no venation, but the file may be considered as being a modified vein, which it undoubtedly is in the case of other locustids, such as *Microcentrum* and *Xiphidium*.

Near the point of attachment to the mesonotum and along the posterior free margin, the edges of this tonotegmen are curved under, and this forms a sort of resonant chamber, which increases the intensity of the sound produced.

Right tonotegmen of male:—This is also chitinous and is somewhat more rectangular than the left; the anterior half of the inner edge is strongly chitinous and like a thin plate; it scrapes the teeth of the file on the left tonotegmen and thus the shrill sound is produced. On the ventral surface towards the anterior margin, and situated transversely across the tonotegmen are about 16 chitinous teeth. As in the left tonotegmen so here the free edges are curved under along the posterior margin and near the point of attachment.

Production of the sound:—The stridulation can easily be observed if a male be located and then approached carefully. If the approach be sudden he will usually stop as soon as the observer is within a few feet, and will often attempt to escape by dropping clumsily to the ground. In the natural position the left tonotegmen overlaps the right. When stridulating it will be noted that the male sits with his head and thorax somewhat depressed, so that a large space is left between the posterior free portion of the pronotum and the dorsal surface of the thorax. When ready to begin, head and thorax, unless already in that position,

are first depressed somewhat; then both tonotegmina are raised slightly in the middle line and vibrated rapidly. They move with a see-saw movement in planes transverse to the body. The shrill sound is produced by the inner edge of the right tonotegmen scraping across the teeth on the under surface of the left. This can easily be verified by the following experiment. The observer should carefully approach a stridulating male, from behind if possible, so that he cannot be seen by the insect. Carefully and gently insert the tip of a sharp-pointed instrument under the left tonotegmen and raise it a little. If the insect has not taken fright and stopped the stridulation, it will be noted that though the tonotegmina are still in active vibration no sound can be heard; immediately the instrument is withdrawn however, the stridulation is plainly audible. While the left tonotegmen is held raised up the whole body of the insect will be seen to quiver violently, showing that the muscles which work the tonotegmina must be of considerable strength.

Previously it has been stated that there are about 16 chitinous teeth on the ventral surface of the right tonotegmen. Since the left tonotegmen always overlaps the right, it is not clear what function the teeth perform on the right. The fact that the number of teeth on the right tonotegmen is less than the number on the left, and that they do not appear to be as strong as those of the latter suggests that the file on the right tonotegmen is in the process of degeneration. In *Gryllidae* both tegmina are provided with a file and a scraper. Thus Landois states that with *Gryllus campestris* there are from 131 to 138 sharp teeth on the under side of one of the veins of each tegmen. The toothed vein of the one tegmen is drawn across a smooth vein projecting from the upper surface of the opposite tegmen. In this species the tegmina may be used indifferently for the purpose of stridulation, i.e. either the left one drawn across the right, or vice versa.

In *Microcentrum laurifolium*, an American locustid, the male has the left tegmen provided with about 55 teeth, and the right tegmen has a scraper at right angles to the file; the sound is produced by the scraper clicking across the teeth as the tegmina are being closed. The tegmina are well veined and serve as

protectors to the underlying wings; the teeth-bearing area is a specially modified vein on the left tegmen; there are apparently no teeth on the right tegmen.

The stridulating apparatus in *Orthoptera* is usually taken to be a secondary sexual character, and is interpreted as being a means of attracting the female, or of exciting her sexually.

I am indebted to Dr. Peringuey of the South African Museum for confirmation of the identity of the species.

LITERATURE.

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2. Descent of man by C. Darwin. Chap. 10.

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The Termites of South Africa.

By CLAUDE FULLER.

(continued from page 52, Vol. III. No. 1.)

V.—TERMES GROUP.

All the members of the genera included in this group are "Fungus growers" and as such fall into two sub-divisions; e.g. those which imprison the breeding pairs within a clay cell and those which seemingly allow these couples the run of the nest. Into the first sub-division fall the genera *Macrotermes*, *Termes* (with *Odontotermes*) and *Acanthotermes*.* Into the second, *Allodotermes* and *Microtermes* (with *Ancistrotermes*).

As between these two sub-divisions, the architecture of the nest differs fundamentally. Those that imprison the breeding pairs centralize their fungus gardens into one large main hive, with or without supplementary cavities round about according to the species. All the nests of *Allodotermes* and *Microtermes* (with *Ancistrotermes*) are comprised of a number of quite small cavities each containing a single fungus garden. These small cavities vary in size and, lying at irregular distances apart in the soil, are connected with a maze like system of tenuous galleries. Biologically the relationship between *Allodotermes* and *Microtermes* is very marked.

*The genus *Acanthotermes* is not discussed in the present paper since I have not met with a representative thereof in South Africa. Sjostedt (1913) records *A. militaris* var. *minor* from "South Africa" but his reference probably relates to specimens from Southern Rhodesia. Such material as I have of *Acanthotermes* was all obtained from nests within vast mounds of *Macrotermes* at Elizabethville, Belgian Congo.

Genus ALLODONTERMES Silvestri.

Allodontermes schultzei (Silv.)

The type localities for this species are Severella and Kang-Kgokong which lie in the heart of the Kalahari some 300 miles west of the Transvaal border. The species has also been recorded from Zululand by Holmgren (1913). I have a number of imagos from Modder River Rail (Griqualand West), Klerksdorp, De Wildt, Pretoria (Transvaal), all in entire agreement with one another and fully answering Silvestri's description.

Series of soldiers have been examined from the Lebombo Flats (Swaziland); Mokeetse, De Wildt, Marico, Warmbaths, Naboomspruit, Klerksdorp, Pretoria (Transvaal); Glen Lyon (Griqualand West). These series of soldiers vary in their average measurements. According to the size of the soldiers the dentation of the mandibles differs within certain limits and the rule seems to be that the smaller the head the less massive are the mandibles and the more decided the dentation.

The following criteria relate to the material here enumerated.

Winged Imago: Antennæ XIX. jointed; pattern, on the whole, very regular; joints III. and IV. sub-equal, V. smaller than either IV. or VI., VII. slightly smaller than VI. and VIII. Body with head fully extended 11.5 to 13; body with wings 21 to 23; forewing with stump 18 to 20; span 37 to 41; headwidth across eyes 1.75 to 1.81, between eyes 1.25 to 1.37.

Soldier: Antennæ XVII. jointed; joint IV. larger than III. or V. but smaller than VI. Total length 4 to 5.5; head with mandibles 2.0 to 2.6; headwidth 0.93 to 1.22; left mandible 0.76 to 0.91.

Worker: All the major and minor workers I have examined have antennæ of XVII. joints with joint IV. always larger than either III. or V.; III. the shortest joint, about half the length of II. A major from Glen Lyon whilst possessing a large joint IV. has III. relatively large and exhibiting a pseudo-articulation. The headwidths of the major workers vary from 1.06 to 1.25. of the minor workers from 0.87 to 0.93.

Allodontermes schultzei sub.sp. *orientalis* s.sp.n.

The imago upon the whole darker than *schultzei* and generally plainly shorter bodied and with shorter wings. Body with head extended 9.7 to 10; body with wings 19 to 20; forewing 16

to 16·5; span 33 to 34. In the series before me the ocelli of the males are regularly shorter than those of the females (20:23) and in the females the ocelli almost touch the eyes, being removed by about one-thirteenth of their long diameter, whilst in the males they are removed by either one-third or one quarter of their long diameter.

The size of the head and pronotum is the same as with *A. schultzei*.

Locality: Delagoa Bay, Portuguese East Africa.

Genus MACROTREMES.

= TERMES s.lat. (sensu Holmgren).

Macrotermes bellicosus (Smeathman) s.lat.

= *Termes bellicosus*. Sm. (1781).

This species was first recorded from South Africa by Hagen but the records should be transferred to *natalensis*. In his Monograph (1858) reference is made to imagos collected by Wahlberg and others by Drege, in the Supplement (1860) to imagos and a queen from Port Natal. There is sufficient evidence supplied by Hagen, quite apart from the localities given, to show that the insects were not, or could not have been *bellicosus* and, inferentially, could only have been *natalensis*.

Two other records that are open to serious objection are those of Sjostedt (1900). One relates to workers collected at Durban (1898), the other to a "king" from Mphone, a mission station near Woodbush, Pietersburg District. *M. bellicosus* does not occur either at Durban or on the Pietersburg plateau, but *natalensis* is abundant both at Mphone and Durban.

All the major soldiers I have examined belong to that form of *bellicosus* to which Hagen gave the varietal name of *mossambica* and are of a smaller and perchance more parallel-sided head type than is *bellicosus* of the Belgian Congo. These soldiers are decidedly characterized by the well defined sculpture of the frons. This sculpture differs essentially from that of *M. natalensis*, *M. waterbergi* and *M. ukuzii*. It is faintly limned, however, on the frons of *M. usutu* and somewhat coarsely expressed on that of

M. swaziae. From the fontanelle two deep grooves diverge forward narrowly to the superior articulations of the mandibles and subtend an entire and elongate triangular ridge the attenuate apex of which extends to the fontanelle and the base of which rests actually upon the front margin of the clypeus. In exhibiting a carina reaching from the fontanelle and passing uninterruptedly over the clypeus, in the comparative narrowness of this, the sharpness of its outline, and the depth of the subtending grooves, the sculpture of the frontal area of *bellicosus* stands apart from that of the major soldiers of other species.

I propose to recognise three South African forms of *bellicosus*; all the imagos differ among themselves in minor characters but, for the present, they may be recognised by the wing-spans thereof.

- (1) Form *mossambica* (= var. *mossambica* Hagen). This form is represented by the following material:
 - a. Soldiers and workers, Têtê.
 - b. Winged imagos, Zambeti.
 - c. Many nest series including kings and queens, Buzi River.
 - d. Winged imagos, soldiers, and workers *ex* nests, Xinavane, Komati River, P.E.A.
 - e. Soldiers and workers, Komati and Umbeluzi Rivers, Swaziland. This is essentially the east coast form of *bellicosus*.
Wing span: 67 to 71 mm. Forewings: 31 to 33 mm.
- (2) Form *limpopoensis* f.nov. This is the northern Transvaal form and was obtained near Messina. It agrees generally with *mossambica* except that the infertile castes are larger and the sculpturing of the the imago head is slightly different.
Wing span: 71 to 72 mm. Forewings: 31 to 34.
- (2) Form *kunenensis* f.nov. This is the Ovamboland form. The soldiers of the same type as *limpopoensis*, the imagos with larger wings.
Wing span: 79 to 80 mm. Forewings: 36.5 to 37 mm.

Macrotermes natalensis (Hav.) s.lat.

= *Termes bellicosus*, in part, Hagen 1858, 1860.

= *Termes natalensis* Hav. 1898.

= *Termes natalensis* Hav. (Sjostedt 1900).

= *Termes natalensis* Hav. (Fuller 1915, 1919, 1920).

? = *Termes parvus* Holmg. 1913.

With a sufficiently elastic description, especially as regards soldier characters and the wing measurements of imagos there is no need to sub-divide *natalensis* into sub-species nor forms. Consequently, the forms here suggested are submitted conditionally and in full realization that, in practice, they may have to be discarded.

Considering the many soldier (major and minor) variants Haviland must have noticed in the numerous nest series he collected, it is extraordinary that his descriptions of these castes are so rigid. This, however, I have sufficiently dealt with (1915).

M. natalensis s.str. is essentially a Natal-Zululand termite and, in that most kaleidoscopic of terrains, the species is seen in its most unstable phase as regards those structural characters of soldiers usually taken as providing the required criteria for taxonomic purposes; there is also a considerable variation in the wing-length and some of the imagos I have examined from lower elevations have the head slightly but regularly shorter than the typical form and in these the ocelli tend to be a little more prominent. Further, among the series before me are some imagos caught in Durban that are remarkably yellow.

In Natal, in the case of each nest series examined, there are always some soldiers (majors and minors) with somewhat thickened heads and these soldiers, as a rule, exhibit angular mesonota. This variant tends to predominate among the nest series brought together by Haviland and now in the Natal Museum. The proportion of such variants is quite irregular, but in nest series further afield I have not found them nearly so common, indeed soldiers with angular metanota are seldom, if ever, found in the Transvaal.

Apart from their proportionately longer and straighter mandibles, the major soldiers of *natalensis* can be at once distinguished from those of *bellicosus* by the less decided sculpturing of the frons. This is regularly shallower and wanting in definition whilst the median ridge, when well expressed is more in the nature of a flatly convex mound and does not extend from the fontanelle to the front margin of the clypeus. There is much variety in the degree to which the sculpturing is expressed, espec-

ially as between nest series, and sometimes it is almost obliterated. When well expressed and when illuminated from the side, the sculpturing imitates that of *bellicosus*. The design may be then summarized as follows: The clypeus is somewhat flat and marked with transverse wrinkles, behind it lies a flatly convex median elevation which reaches about half way to the fontanelle; on each side of this are shallow hollows and in the hinder portion of each hollow lies a small sub-circular flat mound. In front of the fontanelle is a flattened diamond-shaped area and this is sometimes bisected by a very faint, linear carina which extends forward from fontanelle to the median elevation.

The typical imago of *M. natalensis* is brown to black, the paler parts yellowish or yellowish brown, without the warmer chestnut brown generally to be noticed in those of *bellicosus*, (fresh and alcoholic specimens). The following measurements may be taken as applying to *M. natalensis* s.lat.

| | |
|--------------------------|-------------------------------------|
| Head, across eyes | 3: 4 to 3· 7 (typical 3: 6 to 3: 7) |
| Body, with head extended | 18 to 22 (typical 19 to 20). |
| Forewing, without stump | 31: 5 to 40 (typical 35 to 36) |
| Span | 68 to 85 (typical 75 to 79). |

With regard to the lowest wing-measurements it may be said that they are unusual and were taken from a series of fully chitinized males and females obtained by my friend the late Albert Kelly, F.E.S., from a nest in the Campus of the Natal University College, Pietermaritzburg, in December 1915. The imagos from the nest in question are separable at a glance into two series of longer and shorter winged individuals, the bodies being of equal size. The measurements given below were taken from three males and three females of the shorter-winged series and four males and three females of the longer.

Shorter series: Forewings, 31· 5 to 33· 0; Span, 68 to 72.

Longer series: Forewing, 35· 0 to 36· 5; Span, 76 to 79: 5.

Generally speaking the wing-spans from all Natal localities (68 to 78) except Inchanga (78 to 81) are shorter than are those from the higher parts of the Transvaal (75 to 85). In the Transvaal those from the highest points (Johannesburg 5,700 ft.; Witbank 5,300 ft.) are longer than those from contiguous

lower elevations, (Pretoria 4,400, Pienaars River 3,500 ft.). Those again from the lower parts of the Transvaal (Tzaneen 2,300 ft.) are shorter still. The imagos from Lourenço Marques fall into the last mentioned series. The impression one gathers is that wings tend to be longer at higher than lower altitudes but this is rather set at naught by the long winged imagos from Inchanga, 2,000 ft.

Tentatively, I propose to recognise three forms of *M. natalensis*.

1. *M. natalensis* s.str. characterized by its tendency to vary and by the frequency with which thick headed soldiers with angular mesonota are present. Normally a builder of conical mounds, 3 to 4 ft. high. Span, 68 to 81 mm.
2. *M. natalensis* form *transvaalensis* characterized by the higher wing measurements of the imago, the stability of the soldiers and the general absence of such with angular mesonota. Normally a builder of low rounded mounds. Span 74 to 80 mm.
3. *M. natalensis* form *intermedius*, not distinguishable from form *transvaalensis* except that the imagos have shorter wings and insignificantly shorter heads with somewhat more prominent ocelli. This form regularly builds high to very high conical mounds (6 ft. to 12 ft.) and in this stands, in a broad biological sense, between *natalensis* and *bellicosus*. Span, 72 to 74 mm.

Localities: CAPE PROVINCE: (Bolo, Kei River; Kimberley). ORANGE FREE STATE: (Reitkuil; Vierfontein). TRANSVAAL: (Barberton, Bethal, Duivel's Kloof, De Wildt, Johannesburg, Krugersdorp, Lichtenburg, Letsitele, Leydsdorp, Louis Trichardt, Mokeetse, Nylstroom, Naboomspruit, Pietpotgietersrust, Pretoria, Pietersburg, Pienaar's River, Rustenburg, Tzaneen, Waterval Onder, Woodbush, Witbank, Warmbaths). NATAL: (Bellair, Durban, Dumisa, Estcourt, Hillcrest, Haviland Rail, Mount Edgecombe, Muden, Ladysmith, New Hanover, Pietermaritzburg, Winterton, Winklespruit). ZULULAND: (Lower Ukuzi, Mseleni, Lake Sibayi, Lower Umfolosi, Mtunzini).

NOTE. *M. bellicosus* and *M. natalensis* are undoubtedly very closely allied species both in structure and biology. However the two stand well apart both as regards imagos and soldiers and the two are not readily confused. Here it may be mentioned that within the boundaries of the Union of South Africa each species is restricted to its own terrain and I have not so far found any

intermingling. That such does occur elsewhere I have no doubt since I have collected imagos of *natalensis* at lights in Lourenço Marques and received soldiers and workers from Inhambane, two localities in which *bellicosus* is the predominant species.

Sjostedt (1900), writing of the imago of *M. natalensis*, says in effect:

“Remarkably similar in general appearance to *bellicosus* with which it has long been confused. The wings of *natalensis* are, however, longer and more uniformly wide. Of all the imagos of *bellicosus* I have seen the greatest span was 68 mm. On every occasion when, by the aid of the accompanying soldiers, I could determine *natalensis* with certainty, the span of the imago was 72 to 76 mm. As to structure, colour, antennæ, etc. *natalensis* seems to be like *bellicosus*.”

In this connection it will subsequently be shown that as between *natalensis* and *bellicosus* there is nothing specific in the span of the wings and that imagos of both species exist with wing-spans greater than those cited by Sjostedt for *natalensis*. Concerning the span of *bellicosus* Sjostedt says:

“The imago is not constant in size. The smallest I have seen were from Togo but these were accompanied by others of normal size. The imagos generally have a span of 61 to 67 mm.”

By including the smallest Sjostedt mentions the recorded span of *bellicosus* becomes 54 to 67 mm. The imagos of *bellicosus* before me from various South African sources have a span of 69 to 80 mm. so that, the inclusive span must be 54 to 80 mm. whilst the span of *natalensis* from various South African sources is 69 to 86 mm. The convenience of diagnosing the imagos of the two species upon the length of the wings, in South Africa, disappeared very early in my enquiry into the matter. To this it may be added that the length of the wings of these two species seems in some obscure way to be governed by latitude and altitude, the evidence at least pointing to the wings being longer at higher altitudes than lower.



Although the imagos of *bellicosus* have many points of resemblance to those of *natalensis* they are nevertheless consistently different. The heads differ in general appearance because that of *bellicosus* is shorter, the eyes more prominent and the epistome (clypeo-basal) more narrow. Further, both the eyes and ocelli of *bellicosus* are more convex than those of *natalensis* and the ocelli of the former are plainly closer to the eyes than are those of the latter. Apart from the head, the pronotum of *bellicosus* is wider in proportion to its length than is that of *natalensis*, the front margin plainly emarginate whilst with *natalensis* it is straight or but negligibly emarginate, the anterior lateral corners are angular and usually somewhat spread out, with *natalensis* these corners are rounded.

As between the major soldiers of the two species whilst the sculpturing of the frons will at once separate the two, the soldiers of *bellicosus* are also strongly individualized by the relative shortness of their mandibles, the more crooked condition of the left mandible and the almost parallel sides of the head.

Macrotermes swaziae (Fuller).

= *Termes swaziae* Fuller (1915, 1920), soldiers and workers.

Winged Imago: Whole insect dark chestnut brown to black above with pale reddish hyaline wings and large body. Head dark chestnut brown, usually vinous behind; clypeus as dark as rest of head, mandibles brown or bases sometimes vinous; eyes black but not contrasting with head colour, antennæ dark brown; labrum yellow. Pronotum black brown with yellow cross and yellow spots near anterior lateral corners. Meso- and metanotum almost wholly as dark as pronotum. Tergites of abdomen black brown. Below usually chestnut brown, sometimes yellowish brown; tibiae darker than coxæ and femora. Head with a well defined median carina, sculpture of frons much like that of *natalensis* and *bellicosus*; clypeus relatively narrow and somewhat inflated; eyes somewhat flat, as with *natalensis*; ocelli not prominent, oval facing forward, as with *natalensis*, about long diameter from eye.

Antennæ XIX, jointed: III, as long as IV. and V. together, IV., V., VI. subequal, gradually increasing.

Pronotum a little wider than head with eyes (19:18); front margin shallowly emarginate, anterior lateral corners rounded, sides oblique, flatly curvate, hind-margin flatly incurvate; not quite twice as wide as long (19:10).

Mesonotum with hind margin plainly incurvate, that of metanotum flatly incurvate, almost straight.

Measurements: Body, with head extended 25; body with wings 47; forewing with stump 39, without stump 37; span 82; head-width across eyes 3·9 (Wings and bodies of males sometimes a little shorter).

Localities: TRANSVAAL, (Barberton, Nelspruit, Ledzee, Tzaneen, Mokeetse).

Macrotermes waterbergi (Fuller).

= *Termes waterbergi* Fuller (1915, 1920), soldiers and workers.

Imago: In size and general appearance much like the imago of *M. swaziae* but differing at a glance in the more prominent upturned ocelli and the relatively long distance these are removed from the eyes, more than twice the long diameter. Also differing in the clypeus being yellow, the median ridge of the frons less decided, the antennæ paler, and the eyes more convex. Pronotum plainly more than twice as wide as long (21:9); front margin emarginate, anterior lateral corners somewhat acute; much like those of *bellicosus*; a little wider than head across eyes. Meso- and metanotum with hind margins about equally and flatly incurvate. Sternites of abdomen with distinct lateral yellow spots.

Body with head extended 24; body with wings 47; forewing with stump 40; without stump 38; Span 84; headwidth across eyes 4·3.

Localities: TRANSVAAL: Nylstroom, Warmbaths and northern slopes of Magaliesbergen.

Macrotermes usutu sp.n.

Imago: Only one queen is known to me. This stands very close to *M. swaziae*. A comparison shows that the ocelli of *usutu* are shorter and narrower than those of *swaziae*, therefore somewhat further from the eyes; the head and thorax is more polished; the anterior lateral corners of the pronotum more hollowed out.

Pronotum as wide as head. Headwidth 4.0.

Major Soldier: As large as that of *M. swaziae*, the head however reddish yellow and not decidedly sculptured on frons; body and legs yellow. Head massive; flatly arched; sides tapering but not decidedly, somewhat straight; widest behind. Frontal area flatly depressed, sculpturing faint obscurely resembling that of *M. bellicosus* and *M. swaziae*.

Fontanelle raised, very distinct. Antennæ XVII. jointed; joint III. decidedly long. Total length 19 to 20; head with mandibles 9; head width 5·2 to 5·3.

Minor Soldier: Very like that of *M. swaziae* but head and body paler. Head yellow; sculpturing of frontal area as with major, proportionately wider and paler than with major, sides more curvate. Antennæ XVII. jointed; III. longer than IV.

Total length 13·7; head with mandibles 5·7 headwidth 3 to 3·2.

Worker: Head yellowish brown with white spot in middle. Thorax and tergites of abdomen brownish.

Locality: Usutu River, Swaziland.

Macrotermes parvus (Holmg.)

= *Termes parvus* Holmg. 1913.

This species was erected by Holmgren upon the four infertile castes. The material was collected by Trägårdh and the type locality is given vaguely as "Zululand." Judging from the description, *parvus* differs mainly from *natalensis* in point of size and in having no head furrows. I have not seen material agreeing with Holmgren's description except that the insect here described as *M. ukuzii* sp.n. has measurements much in agreement with those cited for *parvus*. It is, however, impossible to compare *ukuzii* with *natalensis* as the major soldiers of *ukuzii* are strikingly different from those of *natalensis* not only as regards the sculpturing of the frons and the form of the mandibles but also in the outline and colour of the head.

Macrotermes ukuzii sp.n.

Major Soldier: Head and antennæ reddish brown; body sordid brown; legs yellowish except tarsi which are brownish. Head elongate; sides sub-parallel and somewhat straight, a little wider behind than in front. Frontal area with a well defined depression which tends to become elongate triangular and to extend beyond the fontanelle so that, in some specimens, the fontanelle lies in a furrow; fontanelle quite distinct and slightly raised, on each side and in front of fontanelle a pair of small but plainly discernible raised points; in the depression and extending from the front margin of the clypeus about half way to fontanelle a low triangular mound subdivided by a transverse wrinkle. Antennæ XVII. jointed; joint III. longer than IV.; the majority of the apical series moniliform. Total length 14; head with mandibles 7·0; headwidth 3·5 to 3·6; left mandible 2·1.

Soldier Minor: Relatively small and with yellower head than major, also with proportionately longer, straighter and finer mandibles. Frontal area not decidedly depressed; fontanelle distinct; paired raised spots laterad and anterior of fontanelle as in major; without a median elevation, such as is present being confined to the clypeus. Antennæ XVII. jointed; joint III. about as long as IV. or faintly shorter.

Total length 8; head with mandibles 3·9; headwidth 1·9 to 2·0; left mandible 1·6.

Workers: Only one worker caste is represented in the series. Head yellowish brown; body sordid; legs yellow; antennæ distinctly pale at base and then becoming dark brown. Antennæ XVII. jointed; III. a little longer than IV. and somewhat cylindrical; V. plainly narrower than IV. or VI.

Total length 6 to 7; headwidth 2·1.

Locality: Ukuzi River, ZULULAND.

Remarks: The major soldier most resembles that of *M. bellicosus-mossambica* especially in the head outline, colour and mandibles. The sculpturing of the frontal area is, however, quite different and the hind margin of the mesonotum flatly incurvate. Inasmuch as it bears a resemblance to the major soldier of *bellicosus-mossambica*, so is it strikingly different from that of *natalensis*. In the size of both soldiers and workers *ukuzii* agrees with *parvus* but taking Holmgren's definition of the latter as sound it is impossible to confuse the two.

MACROTERMES : ANALYSIS OF SPECIES.

I.—WINGED IMAGOS.

(Antennæ XIX joints; III longer than IV).

- A. Largest kinds: Width of third abdominal sternites 7 to 7·5 mm. Headwidth 3·9 to 4·3 mm.
 - B. Abdominal sternites each with two distinct pale yellow spots. Clypeus yellow, paler than head; ocelli somewhat upturned.....*waterbergi* (Fuller)
 - BB. Abdominal sternites without distinct pale spots, Clypeus dark, as dark as head; ocelli not upturned.
 - C. Head and thorax highly polished, corners of pronotum plainly hollowed.....*usutu* sp.n.
 - CC. Head and thorax dull, corners of pronotum not deeply hollowed*swaziae* (Fuller)
- AA. Large kinds: Width of third abdominal sternite 6 mm. Headwidth 3·4 to 3·7.
 - B. Front margin of pronotum broadly emarginate. Eyes and ocelli plainly roundly convex, *bellicosus* (Sm) s.lat.
 - BB. Front margin of pronotum relatively straight. Eyes and ocelli flatly convex *natalensis* (Hav) s.lat.

II.—MAJOR SOLDIERS.

- A. Sides of head tapering decidedly to mandibles; head decidedly wider behind than in front. Antennae frequently XIX jointed. Frons deeply sculptured with a distinct scar about 0.5 mm. in front of fontanelle at apex of median carina *waterbergi* (Fuller)
- AA. Sides of head tapering slightly; head slightly wider behind than in front. Mandibles relatively long. Antennae usually XVII jointed.
 - B. Head thick and massive; mandibles coarse; fontanelle decidedly raised and conspicuous; headwidth over 5 mm.
 - C. Frons deeply sculptured, with distinct median carina; head claret coloured; tergites of abdomen brown to black-brown. *swaziae* (Fuller)
 - CC. Frons faintly sculptured; head reddish yellow; tergites of abdomen yellow. *usutu* sp.n.
 - BB. Head not massive; mandibles strong not coarse; fontanelle not conspicuous. Headwidth under 5 mm.
 - C. Frons not deeply sculptured, with shallow grooves subtending a median mound; headwidth 3 to 4:5 *natalensis* (Hav) s.lat.
 - CC. Frons without shallow grooves; headwidth 3.04 *parvus* (Holmg.)
- AAA. Sides of head relatively parallel; mandibles relatively short and coarse, left decidedly arcuate; frons deeply sculptured.
 - B. Frons with narrow triangular carina extending from fontanelle to cephalic edge of clypeus and subtended by deep grooves..... *bellicosus* (Sm) s.lat.
 - BB. Frons with a triangular depression sometimes extending caudad of fontanelle, otherwise ending at fontanelle; median carina not reaching fontanelle *ukuzii* sp.n.

Genus TERMES* Linn.

= *Odontotermes* s.lat. Holmgren, not *Termes* Holmgren (1912).

For reasons that have already been sufficiently stated, Holmgren's genus *Odontotermes* s.lat. must give way to *Termes*. I propose however to constitute *Odontotermes* as a sub-genus of *Termes* somewhat but not entirely in the strict sense of its definition by Holmgren.

*In the key to imagos given in Part I. *Macrotermes* should have been further distinguished from *Termes* and *Allodontermes* by the condition of joint III. of the imago antennæ. This is longer than IV. in *Macrotermes* and as long as or shorter than IV. in *Termes* and *Allodontermes*.

Holmgren sub-divided *Odontotermes* s.lat., (e.g. *Termes* sensu Linneus,) into three sub-genera using both imago and soldier characters for this purpose. With one of these sub-genera, *Xenotermes*, I am not concerned and amongst our species, I quite fail to separate another, *Cyclotermes* from his *Odontotermes* s.str. either upon imago or soldier characters.

My proposal therefore is to base the sub-genus *Odontotermes* mainly and for the present upon soldier characters.

1. Mandibles not massive, soldiers of one caste; smaller kinds. Headwidth, normally between 1 and 1.5 mm.
..... *Termes*.
2. Mandibles massive, soldiers of two castes or intergrading from small to large; larger kinds with relatively thick heads. Headwidth normally between 1.7 and 3.5 mm.
..... *Odontotermes*

This sub-division seems somewhat artificial but is none the less obvious and useful in practice.

Negligible References and Species: There are a number of references to the presence of species or the distribution of species of this genus in South Africa that must be treated as negligible or subject to correction. The following discussion is submitted with a view to the matter being more thoroughly considered in the light of my remarks.

1. *Termes destructor* Smeathman (1781) This is an imperfectly described and ill defined species with Sierra Leone as its type locality. It needs to be re-discovered there in all its castes and again described from fresh or alcoholic material before any termite from a far-off locality can with assurance be referred to it. Hagen (1858) identified *T. cordofanus* Kollar as *destructor* and these and other Nile imagos have come to be regarded as typical of *destructor*. As the type locality is 3,000 miles away to the east, *cordofanus* may easily be a distinct species. Again, Hagen gave "Port Natal" as a locality for *destructor* but he makes it clear that he was by no means certain about the identity of the South African insect and commented upon its larger size. Sierra Leone is north of the equator on the Atlantic, Port Natal is south thereof and on the Indian Ocean; moreover, as

the crow flies, between four and five thousand miles separate the two places. One could easily afford to ignore Hagen's record were it not that Holmgren (1913) recorded *destructor* from four places in the Natal-Zululand area and spoke of the collection before him being unique as it contained all castes of the ancient *destructor*. Circumstances do not justify Holmgren's determination and from the evidence he puts forward one is justified in concluding that he was dealing either with nest variants or forms of *T. vulgaris* Haviland. Indeed, from two places, Durban and Estcourt, he reports both *destructor* and *vulgaris*, Estcourt being the type locality of *vulgaris*.

2. *Odontotermes tragardhi* Holgrem (1913). This species is based upon material from Pietermaritzburg, Durban and Estcourt. At all three places *T. badius* is commonly met with and the last named centre is the type locality of *badius*. The description given by Holmgren of the major soldiers applies to *badius*. The minor soldiers and workers, and imago's, may be those of *angustatus*. It is, however, very difficult to surmise what the material may have represented but one is led to suspect that the species was erected upon mixed material.

3. *Termes transvaalensis* Sjost. Holmgren (1913) records *transvaalensis* from the Duku Duku Bush in Zululand. It is by no means impossible for *transvaalensis* to occur in Zululand but it is more likely that the record relates to *badius*. The imago's of *transvaalensis* and *badius* are quite different; by no means alike as stated by me (1915); the soldiers are not difficult to tell apart.

4. *Termes badius* Hav. Silvestri (1908) records *badius* from Phitsane, Kalahari, collected there by L. Schultze. Then again Schultze (p. 592. "From Namaqualand to the Kalahari") speaks of the chimneys made by *badius* to the north of Phitsane and reproduces a photograph of the nest of the reputed *badius*. The photograph represents the nest of *T. transvaalensis*. This causes one to question the record given by Silvestri although it is by no means unlikely that *badius* does occur at Phitsane.

5. *Termes vulgaris* Hav. In my "Observations on S.A. Termites" (1915) there are several references to *vulgaris* that relate to *angustatus*, the errors being due to my having confused the soldiers of the two species. The mating recorded for *vulgaris*, pages 340-1, relates wholly to *angustatus*. In the description of the nest, pages 391-3, several lines, four at the end of the first paragraph and four at the end of the discussion, relate to the nests of *angustatus*, as such are found in the Transvaal. Into the descriptions of the soldier and worker, characters of *angustatus* have been incorporated, especially as regards the antennæ and measurements.

6. *Termes latericius* Hav. In the observations mentioned above (1915) there is a description of the mating of *latericius* on page 339. This relates wholly to *badius*. *T. latericius* seems to take to wing mainly after dark and the mating of the sexes has not yet been observed in Pretoria. Mating takes place in Natal in the morning. The females alight on the ground and vibrate their wings as do the females of *badius*. Further, figure 6, Plate XXXI shows two nests; that in the foreground is a nest of *latericius* whilst the tall chimney indicates the nest site of *transvaalensis*.

7. *Termes monodon* Gerst. In the "Observations" (1915) I have questioned the identity of *monodon* and *badius*, pages 456 and 475. From an examination of specimens of *monodon-lujæ*, kindly placed at my disposal by Dr. Wassmann, it is abundantly clear that *monodon* and *badius* are quite distinct. According to Sjostedt (1900) there are seven soldiers of *monodon* from the Transvaal in the Berlin Museum. To the present I have not met with *monodon* in S. Africa.

Sub-Genus TERMES s.str..

Termes capensis De Geer (1778).

One of the localities recorded by Hagen (1858) for this species is Gambia. This should be disregarded. The record for "Kaffirland" has been shown by Sjostedt (1900) to relate to *T. cafferiæ*. From Sparrman's account of his expedition

(1783) it is not difficult to place the type localities of *capensis* as fairly near the sea at St. Francis Bay. His tale of the vicious behaviour of the soldiers, as given in both the English and German versions, should not be taken seriously since there is an obvious confusion of notes.

I have not been successful in obtaining specimens from the type locality and to the present this species and its biology is unknown. However, I possess some fragmentary imagos with the wing span of *T. capensis*. Three of these are from Port Alfred; in their dry condition they are black and have no ridge connecting the ocelli. One is brownish and exhibits a distinct ridge connecting the ocelli; this comes from Grahamstown, and may represent an undescribed species. I have also a winged male from Peddie; this is in alcohol and the body colours are dark brown. Otherwise it agrees with the material from Port Alfred and was captured on the wing in company with many imagos of *Hodotermes peringueyi*. I am inclined to regard this insect as *T. capensis*. In colour and general appearance it agrees with *T. vulgaris* Haviland but exhibits a slightly flatter and wider head, a wider clypeus, a wider pronotum and a larger eye. It is distinguishable from *T. vulgaris* s.sp. *minor*, on these characters and in being paler bodied and in not having the area bearing the fontanelle raised.

The measurements are a little below those recorded for *capensis*. Body, with head extended, 15; body with wings 27; forewing with stump 23, without 22; span 49; head across eyes 2·8.

Termes cafrariae Sjost (1900).

= *T. capensis* Hagen, in part (1858).

The winged imago is strikingly different from other local congeners and, once known, can be recognised at a glance by its black and polished body and the short reddish wings with their peculiarly distinct venation.

The soldier bears mandibles that only differ from those of *latericius* in the presence of one or two small prominences in the incurvature separating the cutting margin from the basal protuberance of the left. The head as a whole is much like that of

the soldier of *latericius* but is yellower in colour, not brick-red, and is wider than that of the major worker, not narrower, as it is with *latericius*. The antennæ are XVI or XVII jointed; when XVI, joint III is longer than IV; when XVII, joint III is shorter than IV.

The workers are more yellow headed than are those of *latericius* and plainly smaller. With both major and minor the antennæ are usually XVII jointed.

Locality: Natal Coast.

Termes vulgaris Haviland (1898).

The only winged imagos I have seen that certainly belong to *vulgaris* are a number collected by Haviland. Such other imagos as I have from the type locality and the higher parts of Natal are kings and queens. All of these exhibit no elevation at the fontanelle. The imagos from the coast of Natal, winged and kings and queens, whilst accompanied by workers and soldiers that are quite agreeable with those of the typical form, differ insomuch that most, but not all, have a distinct elevation at the fontanelle and also in being somewhat darker; the wings are also shorter. For the present I propose to regard these as representing a sub-species calling it *T. vulgaris* s.sp. *minor*.. *T. vulgaris* s.lat. always exhibits two worker castes.

Localities: NATAL: Haviland Rail, Winterton, Ladysmith, Magut, Bellair, Durban, Mount Elgecombe. SWAZILAND: Lebombo Flats between the Umbelusi and Umkomati Rivers.

Termes angustatus Rambur (1842) sens.lat.

= *Termes vulgaris* in part Fuller (1915).

T. angustatus is a species for which an elastic description is required seeing that the imagos and soldiers from different localities tend to vary in a number of minor structural details, and there seems to be some vague relationship between variation and locality.

The soldiers are almost indistinguishable from those of *T. vulgaris* and vary in the degree to which the dentation of the

cutting edge of the mandibles is developed according to the series to which they belong. The imagos exhibit varying wing lengths and may be placed into two main series in accordance with whether the colour of the anterior margin of the head, laterad of the clypeus, is brown or black, or they may be arranged in three main, but more or less intergrading, series in accordance with the width of the incurvature of the middle anterior region of the fourth sternite, the incurvature being four times wider in some series than others.

Having considered all these points of separation together with certain varying features found in examining cleared preparations of the imago head and minor differences noticed in the dentation of imago and worker mandibles, so complex a position has been arrived at that I have for the present abandoned any idea of erecting a series of "forms" and I propose to treat the species only in the wide sense.

Notwithstanding the minor differences here alluded to as tending to characterize series of "species in the making" from different localities, the winged imago of *T. angustatus* s.lat. stands well apart from its congeners and is readily recognisable.

Winged Imago: Moderately large; dark black brown with dark brown wings; somewhat sordid pale legs and creamy white conjunctiva. Head below cream coloured; above black brown except antennæ, antennal fossæ, clypeus and mouth parts. Antennæ pale brown or brown, antennal fossæ pallid or yellowish, clypeus brown margined with yellow brown and with a relatively wide median stripe of yellow brown; (very often the anterior margin of the head laterad of clypeus more or less concolorous therewith); epistome white; labrum and bases of mandibles somewhat sordid yellow brown. Thorax and tergites of abdomen concolorous with head or with the anterior regions of the meso- and metanotum dark brown, not black brown. The T mark and spots of the anterior lateral corners well defined in cleared preparations of pronotum, otherwise invisible or but dimly outlined. Sternites of abdomen dark brown, not black brown, tending to be somewhat paler but never yellowish in the middle; second and third sternites with triangular white spots; sixth sternite of female with a short yellow patch at extremity; eighth sternite of male distinctly yellow in the middle area and around the abdominal papillæ.

Legs, (seen from below); coxæ parti-coloured, inner surfaces pallid yellow-brown, outer surfaces dark brown; femora pallid or sordid cream coloured, tibiæ dark brown fading to yellow brown at tip, (in the males, the brown is of greater extent than

in the females); tarsi concolorous with apices of tibiae. Seen from above: the femora are pale brown, the tibiae yellowish except at upper third where there is a dark brown patch. Pleural plates brown, concolorous with sternites.

Head: behind almost semi-circular in outline; eyes protruding a little from margins but not strikingly convex; surfaces of ocelli perpendicular, not seen when extended head is looked down upon; ocelli well separated from eyes, distant about twice their short diameter, over each a distinct brow; between the ocelli, the frons slopes to the clypeofrontal suture; behind the ridge so formed is a flattened triangular area, towards the back of the flattened area lies an obscure fontanelle point and in front of this extends a faint median keel, on either side of the keel but nearer to each ocellus, a small rounded elevation; in front and somewhat mediad of each ocellus a slight elevation; sculpturing on the whole faint; clypeus straight in front, sides short, rounded, hind margin incurvate, rather flatly inflated with a very fine median furrow.

Antennæ XIX. jointed; III. about half as long as II., never longer than IV., usually shorter and narrower; V. usually shorter and narrower than IV. but longer than III.; sometimes IV. and V. sub-equal.

Pronotum, in a natural position: front margin broadly emarginate; corners boldly rounded; sides tapering and incurvate; hind margin more or less straight. Anterior lobe short, erect, roundly notched, in the middle; posterior lobe pressed down along the hind margin, usually with a short median ridge in the depressed field, in front of this the sculpturing differing in male and female and very variable. The sides appear incurvate because they are bent. The pressing down of the hind margin renders its appearance slightly incurvate. There is no distinct cross groove and the anterior lateral corners are but shallowly excavated.

Hind margin of mesonotum broadly incurvate, that of metanotum somewhat broadly and angularly emarginate; that of mesonotum the wider.

Wings somewhat opaque dark rusty brown (usually smoky black in appearance in live insect) R. with numerous retrograde curved branchlets tapering towards M., R. with or without anals (sectors) near apex, M. usually extending to wing tip; offsets of Cu. usually simple and 1 mm. apart. First sternite of abdomen composed of two elongate pyriform plates united by a narrow band, therefore broadly and deeply incurvate in front; the front margins of the second and third sternites appear to exhibit deep V-shaped incisions; the front margin of the fourth sternite appears incurvate in the middle, that of the fifth roundly produced. The sixth sternite of the female is relatively short, longer than the fifth in the middle, the hind-margin slightly produced in the middle, the produced part yellowish; the sixth sternite of the male slightly shorter than fifth; the seventh about as long as the fifth with an undulate hind margin; the eighth small and notched against the abdominal papillæ.

Measurements: Body with head extended 13 to 17 (the length of the abdomen depends upon whether it is much inflated or telescoped). Body and wings 35 to 40; forewing with stump 32 to 35; without stump 30.5 to 33.5; width of forewing 7 to 8; span 66 to 72.5; headwidth, across eyes 2.5 to 2.8.

Localities :* NATAL: Haviland Rail (3,979); Cedara (3,541) Nov. 1920; Pietermaritzburg (2,218) Oct. 1915; Durban, etc. (sea level) Nov. 1920, Sept. Oct. 1921. PONDOLAND: May 1920. BASUTOLAND: Maseru (4,942) March 1916. ORANGE FREE STATE: Bethlehem (5,334) Feb. 1915. Feb. 1920. TRANSVAAL: Pretoria (4,471) Nov. Dec. 1914, Nov. Dec., 1915, Nov., 1916, Oct., 1918, Nov., 1919, Nov., Dec., 1920; Barberton (2,877); Platrand (5,446). CAPE : Kentani (1,700); Elliotdale (2,500); East London (sea level) May 1915, June 1920; Trappes Valley (1,000), July 1917; Lady Grey (5,262) April 1915; Murraysburg (4,500) March 1921; Cradock (2,855) May 1916; Tylden (2,880) April 1898; Humansdorp (502) March 1919; George (743) Feb. 1920.

There is one soldier caste and a major and minor worker caste. All these stand in such close relationship to the three corresponding castes of *T. vulgaris* in size and general features that in practice I have not been able to separate the two species with certainty in the absence of imagos. The soldiers of the two species seem to differ in that (a) the tooth on the right mandible of *angustatus* is more suppressed, (b) the head is a little more narrowed in front, (c) the sides of the gula more curvate.

Termes latericius Hav. (1898).

This is a species that will have to be treated in the wide sense since there seems to be several forms. Certainly, the soldiers from the Bushveld of the Transvaal are not only larger than those from elsewhere but the nests they come from have the turrets around the airpits uniformly more massive than any seen elsewhere. Unfortunately neither winged imagos nor breeding pairs have yet been obtained in company with the larger headed soldiers so it is not possible to say whether this geographical variant represents a form or is sufficiently different

*The elevations are given in brackets, the date upon which imagos were captured on wing are given and all refer to flights during daylight, e.g. from early morning to dusk, just after or during rain.

to be regarded as a sub-species. The wings of imagos from Pretoria nests are longer than those of insects from near the Natal type-locality, the span being 70 to 72 mm. against 65 to 66 mm.; these latter have, however, a greater span than specimens from Durban of which the span is 62 to 63 mm. The shortest winged I have seen of *latericius*, a male from Pietermaritzburg, has a span of 60 mm. This leads me to question the wing-length of 26 mm. given by Haviland. This measurement would give a span of either 54 or 56 mm., which is far short of 60 mm. I therefore conclude that the figure 26 in Haviland's paper is a misprint for 29.

Localities: NATAL: Generally distributed. TRANSVAAL: Barberton, De Wildt, Groot Marico, Louis Trichardt, Narboom-spruit, Pretoria, Pietersburg, Pienaars River Rail, Warmbaths.

Sub-Genus ODONTOTERMES Holmgren in part.

Odontotermes badius (Haviland) (1898).

= *Termes badius* Hav. Sjostedt (1900 and 1904).

= *Termes badius* Hav. Fuller (1915) (1920).

The imago was described by Sjostedt from Transvaal specimens. The characters given apply to all the winged I have seen from elevations ranging from 2,600 to 6,000 ft. but on the Natal-Zululand coast the wings are much shorter. For this reason I propose to call the coast variety form *littoralis*.

There are *not* two distinct soldier castes, but in any nest series the soldiers may vary considerably in size, intergrading from small to large. Ordinarily their antennæ are XVII jointed, but many may have antennæ of XVI joints this number predominating among members of more juvenile communities.

The workers are in two castes and most have antennæ of XVIII joints.

Localities: TRANSVAAL: Benoni (5350); De Wildt (4000); Duivelskloof (3000); Germiston (5470); Heidelberg (5020); Haenertsburg (4600); Johannesburg (5480); Krugersdorp (5700); Klerksdorp (4340); Lichtenburg (4880); Pietpotgietersrust (3860) Pretoria (4470); Pienaars River Rail

(3580); Tzaneen (2300); Warmbaths (3840). NATAL: Durban (100); Haviland Rail (4000); Manderston (2860); Pietermaritzburg (2220); Tongaat (100); Verulam (100); Winkle Spruit (100); ZULULAND: Umkuzi River. ORANGE FREE STATE: Ventersburg (4600); Grootvlei (4500); Holfontein; Excelsior. CAPE PROVINCE: Kentani; Colesberg (4300).

Odontotermes transvaalensis (Sjost.) (1904).

In general characters the imago is much like the imago of *badius* but differs sharply in the dark smoky brown colouration of the wings.

The soldiers also bear a strong resemblance to those of *badius* but the two species can be at once separated by the difference in the dentation of the right mandible. In *transvaalensis* the right mandible exhibits a clear cut step-like tooth, this is almost as prominent as that on the left and the upper margin is at a right angle with the inside edge of the apical. In *badius* the tooth of the right mandible is not step-like nor is it as prominent as the tooth on the left, further the upper margin slants down from the inside edge of the apical.

Localities: TRANSVAAL: Pienaars River Rail; Pietpotgietersrust, Warmbaths; De Wildt; Brits; Klerksdorp; Christiana. BECHUANALAND: Vryburg.

Odontotermes olkahandjae sp.nov.

Imago and worker unknown, latter said to be very destructive to plants and timber of houses.

Soldier major: Head strikingly massive and thick (1.5 mm.) strongly characterized by a coarse ridge extending from the base of one mandible to that of the other. Head only a little longer than wide; much wider and thicker behind; sides flatly curvate and tapering to mandibles; hind margin broadly curvate; cut off in front by transverse ridge. Crest of ridge bisinuate, front sloping to labrum, behind sloping into a relatively deep triangular depression; in the centre of the depression a short distinct median carina. Labrum relatively short, obtusely triangular. Mandibles relatively short, about half the length of the head; massive, wide, with inbent tips; left with a distinct but relatively small pointed triangular tooth at about half length, tooth

directed inwards, cutting margin below tooth serrate, if not worn. Right with a coarser triangular tooth below half length, the upper edge of which curves into the margin of the apical.

Antennæ XVII, jointed, joint IV. coarser than III. and V., as large as VI. or plainly longer than either III., V. or VI.; IV. tending to subdivide. Headwidth 3·5 to 5·0; head with mandibles 5·7 to 6·4; head without mandibles 3·8 to 4·3.

Intermediate Soldier: Like major, head thick but less robust. Headwidth 2·6 to 2·7. Antennæ as with major.

Soldier Minor: Head flatter and sides tapering less to mandibles. Sculpture of frontal area not nearly so pronounced. Mandibles not so coarse but with similar dentation. Antennæ XVII, as with major. Headwidth 2·1 to 2·3; head with mandibles 3·9 to 4·4; head without mandibles 2·5 to 2·7.

Remarks: The specimens upon which this description is based were sent to me from Okahandja, Damaraland, by Dr. B. Schwonder in 1918. Owing to the fluid in which they were preserved, the bodies are much shrunken and discoloured. I have also one major soldier and several minor soldiers with a few workers that I take to be this species from Ovamboland. These soldiers have reddish yellow heads and somewhat darkened bodies and yellow legs. The major exhibits a small but distinct black eye spot. The workers are relatively small with yellow heads.

TERMES : ANALYSIS OF SPECIES.

I.—WINGED IMAGOS.

Antennæ XIX jointed; III never longer than IV, as long or shorter; sternites II and III of abdomen with triangular white spots.

- A. Sternites of abdomen almost uniformly dark, scarcely paler in the middle. White spots more or less sharply defined.
- B. Legs throughout black except tips of tibiæ and tarsi which are reddish. Body dense black, highly polished. Wings short, wide, reddish brown....*caffrariae* Sjost.
- BB. Legs sordid yellow brown, upper part of tibiæ dark brown. Bodies more or less hairy, not highly polished.
- C. Coxæ distinctly particoloured, a straight line separating the dark from pale area. Head with faint median carina. Sternite VIII of male yellowish in the middle. Body black brown, wings dense brown, Span 66 to 75 mm.*angustatus* Ramb. s.lat.

- CC. Coxæ indistinctly particoloured. Head without median carina. Sternite VIII of male not yellowish in middle. Body dark brown. Wings brownish.
 D. Fontanelle insignificant.
 E. Span 53 to 56. Headwidth 2·5
 *vulgaris* Hav.
 EE. Span 49. Headwidth 2·8 *capensis* de G.
 DD. Fontanelle usually distinct and on a raised area.
 Span 50 to 52. Headwidth 2·5
 *T.vulgaris* s.sp.*minor*.
 AA. Sternites of abdomen laterally dark brown and decidedly yellowish in middle. Sternite VI of female with a large yellow field. White spots well defined. Body above black brown. Tibiæ pale yellowish, tips of tibiæ and tarsi reddish. Wings fuliginous brown.
 *T.latericius* Hav.s.lat.
 AAA. Sternites of abdomen pallid; yellowish to pale brown, a little darker laterally. White spots not sharply defined. Bodies above brown.
 B. Body dark brown, wings fuliginous, eyes rather flatly arched. Without distinct yellowish area at fontanelle *transvaalensis* Sjost.
 BB. Body above rusty brown, wings translucent, rusty brown, usually with yellow streak below R. Eyes protruding, convex, with a large yellowish area around fontanelle.
 C. Span 68 to 70. Headwidth 2·7 to 2·9
 *T. badius* Hav.
 CC. Span 56 to 60. Headwidth 2·7 to 2·8
 *T. badius* s.sp. *littoralis*

2.—SOLDIERS.

- A. Soldiers of one caste not varying greatly in head measurements in a given community. Heads narrower or slightly wider than those of major workers; mandibles relatively fine.
 B. Heads narrower than of major workers. Cutting edge below tooth of left mandible entire, straightly bicurvate; deep incurvature above basal protuberance entire.....*latericius* Hav.s.lat.
 BB. Heads as wide or slightly wider than those of major worker.
 C. Left mandible as with *latericius*, but with one or two small knobs on edge of the incurvature above basal protuberance.....*caffrariae* Sj.
 CC. Left mandible with margin below tooth more or less uneven.
 D. Antennæ usually XV or XVI jointed, infrequently XVII jointed; sides of gulæ relatively straight and parallel. Antennæ of workers XVII jointed*vulgaris* Hav.
 DD. Antennæ commonly XVII jointed; sides of gula relatively curvate. Antennæ of workers XV jointed as a rule*angustatus* Ramb.

- AA. Soldiers varying in head measurements, intergrading from small to large. Heads generally wider to much wider than those of workers without distinct transverse ridge. Mandibles coarse.
- B. With pigmented eyespot; tooth of right mandible with upper edge sloping towards base; tooth of left mandible with upper edge at right angles to margin of apical *badius* Hav.
- BB. Without pigmented eyespot; tooth of right mandible with upper edge at right angles to margin of apical; tooth of left somewhat antrose so that upper edge is at less than a right angle to margin of apical. *transvaalensis* Sjost.
- AAA. Soldiers of three distinct castes. Larger soldiers with a pronounced transverse frontal ridge between bases of mandibles behind this ridge a deep depression, in depression a distinct keel *okahandjae* sp.n.

Genus MICROTERMES Wasmann.

Sub-genus *Microtermes* s.str. (sensu Silvestri).

Concerning the *Microtermes* herein brought under review I am not yet able to say that any one species possesses two soldier castes. Where there are differences of size the soldiers seemingly intergrade from smaller to larger and one does not see any sharp contrast as between a major and a minor such as exists with the allied *Ancistrotermes*. My experience and my collections are still somewhat limited and mainly composed of *M. havilandi* s.lat.; therefore the possibility of other species exhibiting major and minor soldiers is not excluded.

It is quite certain, however, that all our species have two worker castes and the probability is that most have three castes. Where there are three castes, there are two major castes and one minor. All minor workers are characterized by sub-circular heads, the sides and hind margin forming an uninterrupted bend. All major workers have the heads relatively massive, the sides parallel, the hind margin curvate. The larger majors have the head but a shade longer than wide (almost square) the lesser have the head regularly and plainly longer than wide (elongate rectangular).

In the sub-joined descriptions, except as regards *M. havilandi* s.str. only indisputable associations of soldiers and workers with their corresponding imagos have been taken into account and whenever there has been the slightest doubt as to the relationship of workers or soldiers taken at the same time and place with the imagos such have been excluded, pending an opportunity of ascertaining the exact association. Speaking generally, species in this genus are more readily recognised by imago than soldier characters and the characters of soldiers are subordinate to those of imagos. Hitherto the records of *Microtermes* in South Africa have all been in relation to Hagen's species *incertus*. This follows the determination and description of the commonest kind by Haviland (1898) and Sjostedt (1900) as *Termes incertus* Hagen. Holmgren (1913) has, however, made it perfectly clear that the South African insect cannot be *incertus* and that the original determination by Haviland was purely conjectural. Hagen's species is, up to the present, only known by a queen found by Pieters in a mound of *Macrotermes bellicosus* (Sm.) at Tete and the size of the head and pronotum of the type, as recorded by Holmgren, shows that the Zambesi insect has far smaller dimensions than any yet found in S. Africa. For these reasons the Natal insect has been renamed *M. havilandi* by Holmgren (1913).

With regard to the description of this insect, I have not the slightest hesitation in saying that, so far as the imago is concerned, Haviland dealt with imperfectly coloured insects. That is, material collected from nests and in that blanched condition which obtains after the adult stage is reached and before the sclerites are fully chitinized. That this was so is also reflected in the description by Sjostedt (1900) from the types and by most of the specimens in the Haviland collection now in the Natal Museum. As regards the latter, I find them accompanied by nymphs and uncoloured imagos that had but recently completed the final ecdysis when collected. For this and other reasons a revised description of the species is essential to its recognition and this is now submitted; that part relating to the imago being based upon quite mature specimens from Weenen county, where most of Haviland's

termite material was obtained. The measurements for soldiers and workers have been amplified from collections in other Natal localities.

Microtermes havilandi Holmgren (1913) s.str.

= *Termes incertus* Hag. Haviland (1898).

= *Termes incertus* Hag. Sjostedt (1900).

= *Termes incertus* Hag. Fuller (1915).

Imago. Mainly characterized by the erratic jointing of the antennæ, these organs being XVII, XVI, or XV according to the final condition of the basal series of the flagellum. Brownish insects, head insignificantly darker than pronotum with contrasting black eyes. Wings slightly opaque tinged with brown and yellow; C. and R. yellowish brown to wing tip; without any decided yellow streak between R. and M.

Head above, warm brown, often paler in middle of vertex; eyes black; frons pale yellow from side to side; clypeus yellow; antennæ pallid, very faintly fuliginous. Pronotum, anterior and posterior region almost as dark as head with a pale indefinite flare from side to side across the middle also with pale cross and pale spots towards anterior lateral corners. Meso- and metanotum pallid in anterior areas, posterior quarter of both brownish. Tergites of abdomen concolorous with head and usually almost as dark; sternites laterally brown each with a pallid median area subtended by yellow, the sixth sternite of female with a large median yellow area. Legs almost uniformly pale yellow-brown, tibiæ below darker and often with a dark spot near femora.

Vertex of head depressed a little, with an insignificant but plainly raised and distinct fontanelle point. (In cleared preparations, with an oval yellow fontanelle area as in all other *Microtermes*). Antennæ usually XVI jointed with IV a little smaller than III, or III may be decidedly longer and noticeably compound when antenna is pseudo XVII jointed; or with XVII segments when III is very small and half the length of IV; or with XV segments when IV is always noticeably long and often plainly compound. Ocelli roundly oval, short diameter to long as 4:5, removed from eyes by half of short diameter. Clypeus almost twice as wide as long. Pronotum with short anterior lobe slightly elevated in the middle and there distinctly emarginate. notch incurvate; corners well rounded, sides tapering in a somewhat flat curve into rather wide hind margin which is plainly bilobed; almost or quite as wide as head across eyes; length to width (about) as 5:7. Meso- and metanotum both somewhat equally shallowly and angularly emarginate; processes broadly triangular, apices rounded.

Body with head fully extended 8 to 10, body with wings 17 to 19; forewing with stump 15 to 16, span 30 to 33; headwidth across eyes 1.31 to 1.37 (usually 1.37) diameter of eye from above 0.30 to 0.33.

Soldiers. Head yellowish, elongate oval, narrowing in front; mandibles black with pale bases; labrum reaching well beyond basal half of mandibles; clypeus somewhat produced, front margin faintly incurvate, sides rounding into front margin. Antennæ XIV jointed; III and IV noticeably small; III often faintly longer than IV, or III, IV, V increasing in width and length; very rarely XIII jointed when III is long and represents III and IV of XIV expression; even more rarely XII jointed when III very long and represents III, IV, V of XIV expression. Total length 3 to 5.4; head with mandibles 1.37 to 1.62; left mandible 0.57 to 0.59; headwidth 0.70 to 0.93.

Worker Major: (larger). Head almost as wide as long, sides parallel; headwidth 1.00 to 1.06; antennæ XIV jointed; III, IV, V annular gradually increasing in length and width.

Worker Major: (lesser). Head longer than wide, sides parallel; headwidth 0.90 to 0.96; antennæ as with larger major or rarely XIII when IV long and plainly compound.

Worker Minor: Head sub-circular; antennæ XIV, jointed; III and IV short annular, equal or III a shade longer than IV; headwidth, ordinarily, 0.69 to 0.75 (or more rarely 0.69 to 0.81).

Localities: NATAL: Haviland Rail, Muden, Durban, Bellair, Illovo Lagoon. ZULULAND: Umfolosi Rail. TRANSVAAL: Pretoria, Johannesburg, Witbank, De Wildt, Pienaars River Rail.

Remarks: With regard to the diameter of the eyes, I have found none of the imagos from Natal exhibiting a greater diameter than 0.33; those from Pretoria are very regularly 0.35; those from Johannesburg and De Wildt range from 0.30 to 0.35. The mean size of the heads of the soldiers is seemingly dependent upon the nest-series to which they belong. Thus in one Pretoria series the headwidth is 0.72 to 0.78 and towards the bottom of the range, in another, it is 0.80 to 0.85. In the Johannesburg series the range is 0.91 to 0.93. In a Durban series, 0.84 to 0.93.

Microtermes havilandi, form *intermedius* f. nov.

Certain imagos from Klerksdorp, Transvaal, and Bloemfontein, O.F.S., stand apart on account of a distinct yellow streak pervading the wing membrane between R. and M., by the greater diameter of the eyes, 0.37 to 0.39, and by the more bilobed condition of the hind margins of the meso- and metanotum, particularly the latter. The antennæ are XVII jointed but exhibit the same pattern as the XVII expressions of the typical form.

There are no soldiers and workers actually associated with these imagos but some collected quite near to where the imagos were found cannot be separated from the typical form. Those from Bloemfontein have the following measurements: Total length 4·3 to 4·4; head with mandibles 1·50 to 1·56; headwidth 0·78 to 0·82. Accompanied by minor workers with sub-circular heads, headwidth 0·75 to 0·81. Soldiers from Klerksdorp: total length 3·7 to 3·8; head with mandibles 1·56 to 1·62; headwidth 0·81 to 0·83.

Microtermes havilandi, form *occidentalis* f.nov.

Of this sub-species I have imagos from Graspan, Modder River Rail (Griqualand West) and Olivewood (Colesberg). These resemble the form *intermedius* in having a yellow streak below R. The diameter of the eye is larger 0·40 to 0·42. They stand apart in the characters of the meso- and metanotum; these parts are narrower, the sides straighter and the hind margins plainly deeply and angularly emarginate. The sides of the pronotum taper more rapidly than in the typical form. Antennæ XVII, XVI, and XV. Body with head fully extended 9 to 10·5; body with wings 17 to 19; span 32 to 34. Otherwise as with typical form.

Microtermes lounsburyi sp.n.

Imago: Somewhat uniformly dark brown, head black brown; wings transparent, very faintly fuliginous with costa and radius well defined to apex and relatively straight median. Wings noticeably short in comparison with our other *Microtermes* (except *M. umfolosii* sp.n.). Head uniformly black brown; eyes black and not in contrast; clypeus varying from pale yellow to brown with a pale median line; antennæ brown. Pronotum brown, paler than head, with well defined pale cross and broadly comma shaped spots near anterior lateral corners. Meso- and metanotum pale over anterior quarter, remainder brown. Tergites uniformly brown, as dark as pronotum. Sternites brown, not as dark as tergites. Legs brownish, tibiae plainly darker; coxæ pale yellowish, femora with yellow and brown stripes; tibiae brown throughout or paler in basal half; tarsi pallid and contrasting with rest of legs.

Antennæ XV joints; IV larger than both III and V; IV as large as VI. Ocelli small, not protruding; broad oval, almost semi-circular in outline, half the long-diameter from eyes. Clypeus twice as wide as long, inflated. Pronotum with almost straight

front margin roundly emarginate in the middle; sides roundly curve at anterior angles then tapering somewhat straightly to hind margin; hind margin short straight or almost imperceptibly incurvate; one third wider than long; just as wide as head including eyes, or faintly wider. Hind margins of meso- and metanotum almost straight to slightly incurvate, that of mesonotum sometimes slightly more incurvate than that of metanotum; processes not acute but broadly rounded.

Body with head fully extended 9 to 9.5, with wings 12 to 13; forewing with stump 10.2 to 10.7; span 21.5 to 22.5; head-width across eyes 1.12, pronotum width 1.12.

Soldier: Head yellow, somewhat elongate oval; mandibles about half as long as head, basal half distinctly yellow; labrum reaching beyond half length of mandibles. Antennæ XIII jointed, III decidedly small. Total length 2.80; head and mandibles 1.31; headwidth 0.64 to 0.68; Left mandible 0.48.

Worker major: Head elongate, subrectangular, rounded behind, width 0.76 to 0.80. Antennæ as with soldier.

Worker minor: Head sub-circular; width 0.62, antennæ as with soldier.

This species, together with *M. umfolosii* sp.n. from Zululand, belongs to the series represented by *M. congoensis* Sjoestedt (1911). Both differ in having the pronotum of the imago as wide as the head. The imago of *M. umfolosii* differs from that of *M. lounsburyi* chiefly in having the ocelli more distantly removed from the eye.

Locality: Pienaars River, Bushveld, TRANSVAAL. Found in same field as *Microtermes etiolatus* sp.n.

Microtermes mopheetsei sp.nov.

Imago: Somewhat uniformly brown; head darkest but not contrasting strongly with thorax; wings hyaline; C. and R. distinct to wing-tip black brown at base fading at about half wing length; C. fading before R; M. and Cu. transparent but clearly defined. Head above black brown; clypeus dark brown, not as dark as rest of head, sometimes with paler median line; eyes black, not in contrast; antennæ pale brown. Pronotum brown, paler than head, concolorous with clypeus; with well defined pallid cross. Meso- and metanotum brown, anterior half of both somewhat paler, remainder as dark as pronotum. Tergites of abdomen uniformly brown, as dark as pronotum; sternites as dark as tergites with pallid or pale yellowish median areas. Legs: coxæ brown and yellow, mainly brown, femora brown below; tibiae cream-coloured with dark spot near femora; tarsi pallid. Antennæ XV jointed; III smallest; IV and V equal and a little smaller than VI; rarely XIV jointed when V long and compound. Ocelli not prominent about half diameter from eyes. Pronotum, seen directly from above, with nearly straight incurvate margin but anterior lobe actually shallowly and roundly emarginate;

sides roundly curve to hind margin which is slightly incurvate; not quite twice as wide as long; not quite as wide as head with eyes (20:21). Hind margins of meso- and metanotum broadly incurvate; processes neither acute nor produced.

Body with head fully extended 9; body with wings 16·5 to 17; forewing with stump 13·5 to 14; span 28 to 29; headwidth across eyes 1·30 to 1·37; pronotum 1·25 to 1·31; diameter of eyes, from above, 0·38.

Soldier: Head yellow; elongate; sides somewhat parallel, faintly curve; width seven-ninths of length. Mandibles yellow at bases; more than half the length of head (9:15). Labrum reaching to beyond half of mandibles. Antennæ XIII jointed; III very small; IV, V, sub-equal, smaller than VI.

Total length 3·0; head with mandibles 1·5; headwidth 0·72; left mandible 0·54.

Locality: Mokeetse, Koedoes River, N.E. TRANSVAAL.

Remarks: This species stands near to *M. albopartitus* Sjost. (1911) and may ultimately have to be considered as a geographical form thereof.

Microtermes umfolozii sp.n.

In its general characters and size this species approximates *M. lounsburyi*. The body is, however, a more uniform black-brown, the clypeus strikingly dark black-brown; the ocelli are plainly further removed from the eyes.

Locality: Umfolozi Rail, Zululand.

Remarks: It is not impossible for *umfolosii* to be the imago caste of *M. longiceps* Holmg.

Microtermes longiceps Holmg. (1913).

Locality: Lake Kosi, ZULULAND. This species is only known to me by the description.

Microtermes dubius sp.n.

Imago: The colours and the wings of imagos approximate *M. mokeetsi* but the clypeus distinctly pale yellow. Anterior regions of the meso- and metanotum pallid with brownish spots. Legs pale brown, striped with cream, tibiæ paler towards tips with dark spot near femora, tarsi pallid yellow.

Antennæ XIV jointed, III large, usually compound and then as long or longer than II, also longer than V but narrower, always longer than IV or V. Ocelli small, almost round (5:6), two sixths of long diameter from eye. Eyes small.

Pronotum: Almost as wide as head with eyes (20:21), longer than half the width (5:3); front margin in two wide curves

plainly but shallowly emarginate in the middle; sides broadly curvate, subparallel curving into the faintly incurvate hind-margin; hindmargins of meso- and metanotum plainly angularly emarginate.

Body with head fully extended 7 to 8; body with wings 14; forewing with stump 13; span 27; headwidth across eyes 1.18 to 1.25; diameter of eyes from above 0.28.

Locality: DAMARALAND: (The Dornveld near Windhoek).
Collected by Dr. Hartig.

Remarks: Dr. Hartig also collected a soldier and some workers in the same place at a later date which may belong to this species. The head of the soldier is elongate, sides subparallel and faintly curvate; mandibles just half the length of the head; labrum reaching but a little over basal half of mandibles; Antennæ broken, III large and plainly compound, III longer than either IV or V and as long as II. Total length 2.9; head with mandibles 1.3; headwidth 0.67. The workers are in two castes. Majors with sub-rectangular heads longer than wide; antennæ XIII jointed, III minute. Headwidth 0.74 to 0.75. Minors with sub-circular heads. Headwidth 0.60. Antennæ broken. According to Holmgren's tables (1913) the imago should stand near the insect therein mentioned, but not described, as *M. albonotus*.

Microtermes etiolatus sp.n.

Imago. Head contrasting sharply with remainder of body; wings hyaline, C. and R. black brown in basal sixth only, remainder blanché; M. and Cu. obliterated. Distinctly different at a glance from all our other species of *Microtermes*.

Head above warm ferruginous; eyes black; clypeus very pale yellow and contrasting strongly, with a fine dark median line; antennæ pallid. Pronotum pale uniform yellow with a pair of red brown flecks in transverse furrow; sometimes slightly dimmed with brown when pale cross can be discerned. Meso- and metanotum pale yellow: Tergites of abdomen cream coloured dimmed slightly with brown. Sternites creamy. Legs quite pale; tibia faintly darker with a brown spot near femoral articulation.

Antennæ XVI or XV jointed; when XVI jointed, III smallest, when XV jointed IV a little longer than V; occasionally XV when III long and plainly compound; occasionally XVI with III IV very short. Ocelli prominent, roundly oval less than half long diameter from eyes (4:11). Pronotum almost as wide as head with eyes, not twice as wide as long (13:21); front margin

barely perceptibly emarginate; sides roundly curvate, bending into hind margin which is almost straight and but faintly incurvate. Meso- and metanotum with regularly incurvate hind margins. Body with head fully extended 9 to 11·5; body with wings 17·5 to 18·5; forewing with stump 13·5 to 15·5; span 28 to 32; headwidth across eyes 1·30 to 1·37; diameter of eye from above 0·37 to 0·38.

Soldier: Head yellow, elongate rectangular, flatly curved behind; labrum reaching over basal half of mandibles. Antennæ XIII jointed, III very small. Total length 3·40 to 3·50; head with mandibles 1·44 to 1·50; headwidth 0·68 to 0·70.

Worker major: Head sub-rectangular longer than wide; antennæ as with soldier; headwidth 0·81.

Worker minor: Head sub-circular; antennæ as with soldier, headwidth 0·62.

Localities: LOURENCO MARQUES (Xinavane, Umkomati R.); TRANSVAAL (Pienaars River Rail).

Remarks: *M. etiolatus* stands near *M. feae* Silvestri (1912) a species described from Fernando Po.

Sub-genus ANCISTROTERMES Silv.

I have not been able to determine how many representatives there may be of this genus in South Africa but it is very difficult for me to think that the series of soldiers so far collected represent more than one species. If this be so the species here described as *A. lebomboensis* is essentially north-eastern in its distribution on either side of the Lebombo Mountains from the Drakensberg to the sea as far south as the Usutu-Maputu Rivers. To the north it extends further inland along the valley of the Limpopo to at least as far as the town of Messina. The biology of the species is not different from that of *Microtermes* and the nest or portions thereof may often be found in the mounds of *Macrotermes bellicosus* and *M. natalensis* or in the clay turrets built by *Termes latericius*.

Ancistrotermes lebomboensis sp.n.

Imago: The dealate male and female (king and queen) exhibit the following characters: Head above vinous; eyes black; epistome yellow with a dark median line, mandibles yellow except teeth; antennæ white. Pro- meso- and metanotum wing-stumps and abdominal tergites brown, slightly contrasting with vinous head. Pronotum with pale cross and pale spots near anterior lateral corners. Sternites paler than tergites. Legs yellow.

Vertex of head not flattened nor depressed, with a small raised fontanelle point. Eyes flatly rounded. Ocelli small, sub-circular, very deeply inset, quite one diameter from eye. Clypeus almost half as long as wide (21:45).

Antennæ mutilated; joint IV larger than III or V and as long as VI; III and V sub-equal.

Pronotum as wide as head across eyes, longer than half of width (15:28); semicircular in outline; viewed from above the front margin straight, but anterior lobe erect and shallowly emarginate; sides and hind margin in a relatively equal curve, or hind margin insignificantly bilobed. Mesonotum with hind margin somewhat angularly emarginate; metanotum with hind margin regularly incurvate.

Body with head fully extended (male) about 12; headwidth across eyes 1.75; between eyes 1.37; head length from margin of clypeus 1.56; Diameter of eye from above 0.40.

Soldier Major: Head reddish yellow, somewhat short rectangular oval and thick; about as wide as long. Mandibles almost as long as head; black, at the base yellow, tips strongly in-bent, left with an insignificant but constant toothlet at upper third, Labrum relatively short.

Antennæ pallid; XVI jointed; III and IV sub-equal and both plainly smaller than V; or XV jointed when III is small and IV large and plainly compound.

Total length 5.5 to 6; head with mandibles 2.2 to 2.3; headwidth 1.25 to 1.30; mandibles 1.0.

Soldier Minor: Head pale yellow of the same shape as with major; mandibles almost as long as head, brown, at the bases yellow, curved but much finer and straighter than with major, left without toothlet. Labrum relatively short. Antennæ XV jointed; III very small, annular; IV longer than V; occasionally XIV jointed when III is long and compound. Total length 4.0 to 4.7; head with mandibles 1.8; headwidth 0.87 to 0.93.

The minor soldiers are usually in two grades, those with longer and those with shorter bodies.

Worker Major: Head subrectangular, a little wider than long; in three grades. Headwidths: larger grade 1.44, intermediate grade 1.37, smallest grade 1.31.

Antennæ XV jointed; III small; IV longer than V and often plainly compound; or XVI jointed with III, IV, V, relatively small and increasing in size or with IV smallest.

Worker Minor: Head sub-circular. Headwidth 0.94. Antennæ XV or XVI as with majors.

Localities: The male and female with major, intermediate soldiers and workers from Xinavane, Umkomati River, LOURENCO MARQUES. Major, intermediate and minor soldiers with workers from Messina, near Limpopo River. Soldiers and workers from Lebombo flats, Swaziland; Nelspruit, Leydsdorp. Ledzie, and Letsitele, TRANSVAAL.

Remarks: According to Silvestri (1914) the major soldier herein described should be that of *A. latinotus* Holmgren. Quite similar major soldiers and minor soldiers also accompany a series of imagos that I have from Elizabethville, Belgian Congo. These Congo imagos have very much the same measurements as those ascribed to *latinotus* but the king and queen from Xinavane seem to differ widely from them in having much smaller ocelli, the long diameter not being more than 0·17 whilst Silvestri gives the long diameter of the ocellus of *latinotus* and *crucifer* as 0·45 and 0·50 respectively.

The Congo imagos differ from the king and queen of *lebomboensis* inasmuch as the heads of the former exhibit the same median keel and sculpturing that is exhibited by *Allodoterme schultzei*, a feature wanting in the local insects.

Associated with a number of soldiers and workers collected at Messina I have found two smaller soldiers. These have every appearance of belonging to *Ancistrotermes* but the labrum extends over the greater part of the mandibles. In some respects they appear to agree with the description of *Microtermes cavithorax*. I append a description of these two soldiers leaving their position for the present undecided.

Head yellow, sub-circular in outline, as wide as long, sides plainly constricted between antennal fossæ and articulations of mandibles; quite different in shape from major and minor soldier described above. Mandibles brown, not as long as head (5·7) relatively straight, fine with inbent tips. Labrum relatively long, reaching over greater part of mandibles.

Antennæ XIV jointed; joints III, IV, V increasing or IV somewhat the shorter. Head with mandibles 1·15 to 1·18; head length 0·7; headwidth 0·7; mandibles 0·48 to 0·52.

MICROTERMES: ANALYSIS OF IMAGOS.

I.—Antennæ XVIII jointed *Ancistrotermes*

II.—Antennæ XV, XVI, XVII, jointed *Microtermes* s.str.

A. Head contrasting decidedly with rest of body, ferruginous, body yellow.....*etiolatus* sp.n.

- AA. Head and body brown to dark brown, not contrasting with rest of body
- B. Eyes black, not contrasting with colour of head; dark insects.
 - C. Wings with C. and R. fading in colour at half length.
 - D. Clypeus dark brown *mokeetsei* sp.n.
 - DD. Clypeus pale yellow *dubius* sp.n.
 - CC. Wings with C. and R. coloured to wing tip.
 - D. Clypeus black brown..... *umfolosii* sp.n.
 - DD. Clypeus pale yellow to pale brown
 - *lounsburyi* sp.n.
- BB. Eyes black, contrasting with paler brown head.
 - C. Wings without distinct yellow streak below R. Diameter of eye 0·30 to 0·35 mm.
 - *haviglandi* Holmg.
 - CC. Wings with distinct yellow streak below R.
 - D. Diameter of eye 0·37 to 0·39; hind margin of meso- and metanota bilobed, not angularly emarginate. *haviglandi*, f. *intermedius* f. nov.
 - DD. Diameter of eye 0·40 to 0·43; hind margin of meso- and metanota deeply and angularly emarginate .. *haviglandi*, f. *occidentalis* f.n.

VI.—APICOTERMES GROUP.

The placing of this group is quite arbitrary and the inclusion of *Hopolognathotermes* solely a matter of convenience since no representatives of either genus included have yet been studied by the writer. According to Holmgren, *Apicotermes* belongs to the *Microtermes*. group, whilst Silvestri's two African genera *Hopolognathotermes* and *Allognathotermes* have not yet been accorded any place in Holmgren's scheme. Silvestri, however, indicates a relationship as existing between these three genera and he is followed in arranging them as a group in the present sequence between *Termes* and *Nasutitermes*.

Genus HOPOLOGNATHOTERMES Silv. (1914).

Hopolognathotermes sp.

Specimens representing callow soldiers in the fourth instar were found in a tube marked "contents of queen cell" in the collection of the Albany Museum. There were only a few of these soldiers and they were associated with a queen, workers and soldiers of *Termes* (*Odontotermes*) *transvaalensis* obtained at Vryburg. The determination is by Dr. Silvestri.

Genus APICOTERMES Holmg. (1912).

Apicotermes tragardhi Holmg. (1913).

This species is the type of the genus. All three castes were described by Holmgren, the specimens coming from Lake M'Kosi, Amatongaland, collected 30th November, 1905.

VII.—NASUTITERMES GROUP.

To this group belong those termites with nasute soldiers. According to Holmgren's classification (1912) these all fell to the genus *Eutermes* sens. lat. and this was subdivided by Holmgren into sixteen sub-genera. Banks (1920) has shown, however, that "Eutermes" must be reserved for those which in Holmgren's classification have been placed in the genus *Microcerotermes* Silvestri. Banks has set out his reasons for applying "Nasutitermes" to *Eutermes* s. str. Holmgren and, at the same time, gives generic rank to the sub-genus *Constrictotermes* Holmg. The South African species here discussed represent four of Holmgren's sub-genera and for our present purpose these particular sub-genera are accorded generic rank. Although a number of African nasutes belong to the genus *Nasutitermes* Banks, none have so far been met with in South Africa. There would appear to be no essential difference between the imagos and nasuti of either *Nasutitermes* or *Trinervitermes*, other than there is one soldier caste in *Nasutitermes* and two or three in *Trinervitermes*.

Genus TRINERVITERMES.

There are many records of species of this genus in South Africa that call for careful review. The first is *Termes trinervius* Ramb. reported by Hagen (1858). This is a negligible reference and the insect reported is probably *T. gemellus* Sjostedt. The second is Haviland's (1898) identification of the common upland species of Natal as *trinervius* Ramb. This identification was purely speculative; the species is here described as *havilandi* sp. n. The third is that of Sjostedt (1900); this authority fol-

lows Haviland and the Natal insects he reports upon are also *havilandi*. In 1908, Silvestri determined specimens from Namaqualand and the Kalahari as *trinervius* Ramb. (sensu Sjöstedt) and reduced *dispar* Sjöstedt to a synonym thereof. Later, (1914), Holmgren set aside this determination and redescribed Silvestri's insects as a new species under the name *kalaharicus* and declared it to be different from both *trinervius* (sensu Sjöstedt) and *dispar*. From the two descriptions, and with insects from Namaqualand before me, I can only regard *kalaharicus* Holmgren as a form of *gemellus* Sjöstedt.

T. dispar Sjöstedt (1904) is a Zomba insect and only the characters of the soldiers and workers are known. Nevertheless, Holmgren (1914) has described as "forms" of *dispar* certain material from Zululand giving to some extent the characters of the imago of one of these two forms. Without doubt the two forms are one and the same species. As it is altogether impossible to identify an imperfectly defined species of this genus, as is *diopar*, unless obtained in the type locality, it is most undesirable that this record of *dispar* should stand, especially as there is every likelihood that the Zululand insect is not *dispar*. It should therefore be referred to as *T. zuluensis* Holmg. and *disparoides* be relegated to the nom. negl.

T. gemellus Sjöstedt (1904) is an imperfectly defined species erected on nasuti and workers in the absence of imagos. Part of the type series is in the South African Museum and these nasuti seem to be undersized (nanitic) representatives of the common nasute found about Capetown. It so happens that there is no precise information as to the exact type locality of *gemellus* but as there is no reason to suspect that the material came to the Museum from far afield, I have treated the predominant S.W. species as *gemellus*.

T. trinervoides Sjöstedt (1913a) was erected upon four castes and constitutes the most reliable record of any South African species of the genus. Assuming that the printed description abounds in typographical errors, and there is a fair amount of evidence pointing to this, I have redescribed the species from a nest series found in the lower Karroo, the terrain of *trinervoides*.

From the lower elevations of Natal, Holmgren (1913) has reported four species, all of which rest upon vague and unreliable criteria and of none of which the imago is known. These are called *trinerviformis*, *auriceps*, *bulbiceps*, and *dubius* and are described in the order mentioned. I have been able to demonstrate that all are one and the same species.

As all the imagos of this genus coming under my notice have so many characters in common, I have refrained from giving lengthy descriptions and in place thereof submitted synopses for both imagos and nasuti including in these the other representatives of the group so that the synopses take the form of a Key to the Group.

In order to make these synopses more compact certain abbreviations have frequently been introduced. Thus "pro," "meso," and "meta." stand for pronotum, mesonotum and metanotum, and unqualified references to these sclerites relate to their posterior margins. All measurements are given in millimetres without the "mm." The word "forewing" is represented by the letters f.w. and the measurement given is the length of the blade without that of the wing-stump; the width, when introduced, is separated from the length by the sign \times . "Head width" is abbreviated to H.W. and is, unless otherwise stated, the shorter distance at which the inner margins of the eyes lie apart. "Head length" is contracted to H.L. and includes the length of the clypeus. Fontanelle is reduced to "font." Colour notes relate to specimens submerged in alcohol. References to the fontanelle relate mainly to its appearance when heads are cleared and mounted in balsam.

I have divided the imagos of *Trinervitermes* into two groups according to whether the lateral pores upon the sternites of the venter are surrounded with brown or not. Here it may be added that those species which exhibit no zone of colour around these pores also differ from those that do in having rounder heads, proportionately large eyes and broad ocelli; and, further the tergites of the venter can be described as yellow with brown patches around the lateral pores, whereas the other species tend to have more brown than yellow on these tergites. There also seems to be a constant difference in the ratio of the head length,

as taken from the clypeo-frontal suture, to the head width between the eyes. In the rounder-headed group with pallid venters the head width stands to the head length as 20:32, in the other group, as 20:35.

All *Trinervitermes* I have observed, certainly all those enumerated here, are nocturnal harvesters of grass and grass seeds and store hay in their many-celled nests. All except *pretoriensis* sp. n. are mound builders; this species makes hollows beneath fairly large stones and there makes a cellular nest. Among the mound-builders only one makes a mound that can be said to be typical of the species; this is *hurumanensis* sp. n. The mound nest of this insect is columnar, swollen at the top and usually six feet high. The mounds are as a rule obliquely upright, leaning away from the prevailing wind and, from a distance, look like tree stumps.

Trinervitermes trinervoides Sjöstedt (1913a).

There is no doubt in my mind that the insect herein characterized is Sjöstedt's species. My material is from Willowmore in the lower Karroo as is the type locality, Laingsberg.

Locality: De Vlakte, Willowmore, (F. Thomsen, November 1920, all castes from one nest). Shaw Park, Bathurst (D. Gunn, November 1920, three nest series, all castes).

Trinervitermes gemellus Sjöstedt (1904).

? = *Eutermes trinervius* (in part) Hagen (1858).

For reasons already stated I regard this Stellenbosch and Cape Flats species as the imperfectly defined *gemellus* of Sjöstedt.. The insect reported from the Cape by Hagen may prove to be *gemellus* on a scrutiny of the posterior margins of the meso- and metanotum.

Locality: Elsenberg, Mulder's Vlei (F. Petty, November 1918; six nest series, all castes).

Trinervitermes gemellus form *kalaharicus* Holmg.

= *Trinervitermes kalaharicus* Holmgren (1913).

Represented by a nest series from Springbok, Klein Namaqualand, (Rev. Kling, November 1918) this should be the insect

from Steinkopf referred to *trinervius* by Silvestri (1908) and redescribed as *kalaharicus* by Holmgren.* The imagos only appear to differ from the type in having wider heads, 1.9 to 1.95. The ocelli are about or a little less than their short diameter from the eyes. The antennæ are XVI. and XVII. jointed, commonly XVI., when joint III. may occasionally be a shade longer than II.

The major nasuti differ in being larger, in having the nose shorter than the head height (18:19) and in exhibiting XIV. jointed antennæ with joint III. noticeably longer than II. (9:7) and almost as long as IV. The hind margins of the antennal foveola a little before half the head length (22:4 and 22:23). Head length 2.4; height 1.00; width 1.4 to 1.5.

The minor nasuti exhibit antennæ of XIII. and XIV. joints. In XIII., joint III is exceptionally long and a compound (III. plus IV. of the XIV. expression). In XIV., joint III. varies in length from being as long as II. to plainly longer as in the major.

The workers exhibit XV. jointed antennæ and a head width of 1.52-1.62.

Trinervitermes gemellus sub. sp. *thomseni* s.sp.nov.

Represented by a nest series from Pearston, Somerset West (F. Thomsen, November 1920). The imago antennæ are XVI. and XVII. jointed with joint III. a shade longer than II., not shorter. The ocelli are larger than in the typical form and half the short diameter from the eyes. Both major and minor nasuti exhibit antennæ of XIV. joints with joint III. about as long as II. The heads of the major nasuti are paler than in the typical form and the bodies and legs pale golden yellow, not sordid; further the heads are a little more elongate and plainly smaller (head width 1.16, *gemellus* 1.37).

Trinervitermes trinerviformis Holmgren (1913).

= *Trinervitermes auriceps* Holmgren.

= *Trinervitermes bulbiceps* Holmgren.

= *Trinervitermes dubius* Holmgren.

= *Termes trinervius* (in part) Fuller (1915).

*The criteria given by Holmgren seem to have been selected from nanitic forms amongst those reported by Silvestri.

Nasuti and Workers:—I am not able to point to any critical differences between these castes of *trinerviformis*, *havilandi* and *kurumanensis*. One may only say that as between large reproductive nests the nasuti of *trinerviformis* are upon the whole larger than those of *havilandi*.

It very often happens that in a nest series of *trinerviformis* the intermediate and major nasuti so intergrade that they cannot be definitely separated, unless those with joint III. almost twice as long as II (11:6) are assumed to be majors and those in which this joint is a little longer than II., intermediates. I may add that for the different nest series one never gets exactly the same range of measurements nor any complete agreement as regards the three dimensions as the following example well illustrates:—

| | | | | |
|-------------|----|----|----|----|
| Head width | 25 | 25 | 25 | 26 |
| Head length | 42 | 43 | 46 | 43 |
| Head height | 17 | 19 | 18 | 17 |

If insects from small nests are also considered the range of the different dimensions is extraordinary. I select one dimension, the head length, to illustrate this. For thirty one nests at Pietermaritzburg, from 4.75 inches to 3 feet in diameter, this was found to vary all the way from 1.94 to 2.79 for the major-intermediate nasuti of the communities.

The following are the ranges and averages for nine major-intermediate and 12 minor nasuti taken at random from two reproductive nests.

Major: Head, width 1.30 to 1.60 (av. 1.48); length 2.40 to 2.79 (av. 2.51); height 0.98 to 1.25 (av. 1.08).

Minor: Head, width 0.79 to 0.98 (av. 0.90); length 1.85 to 2.04 (av. 1.94); height 0.63 to 0.80 (av. 0.67).

Whilst this shows a higher range than that ascertained for *havilandi* the averages are not outside the *havilandi* range.

The insects upon which the specific criteria are based are representatives of nest series collected by the writer at Pietermaritzburg, Durban, Illovo Lagoon and Dumisa or the same terrain as that of Holmgren's species *trinerviformis*, *auriceps bulbiceps* and *dubius*. There is no question in my mind as to the correctness of the synonymy set out, but there remains a possibility that the in-

sects from Lake Sibayi referred to *auriceps* by Holmgren represent a species different from *trinerviformis*. It may be added that if the nanitic and giant nasuti of *trinerviformis* are taken into account then the antennæ are XII., XIII., XIV. and XV. jointed.

Trinervitermes havilandi sp. n.

= *Termes trinervius* sensu Haviland (1898).

= *Eutermes trinervius* sensu Sjöstedt, from Natal (1900).

= *Termes trinervius*, in part, Fuller (1915).

Locality: Haviland Rail, Natal, nest series collected by the writer from the same spot as that in which Haviland obtained his material. This species may prove to be widely distributed in the Transvaal and Orange Free State.

Trinervitermes zuluensis Holmg. (1913).

= *Trinervitermes dispar* f. *zuluensis* Holmg. (1913).

= *Trinervitermes dispar* f. *disparoides* Holmg. (1913).

So far as one can gather from the meagreness of essential criteria in Holmgren's description, *zuluensis* should fall into the *trinervoides* group. Up to the present I have seen no imagos from Zululand that do not belong to *trinerviformis*.

Localities: Umfolosi Drift, Kosi Bay; Mhlanzinga (Zululand).

Trinervitermes fuscus sp. n.

The imago of this species is quite outstanding on account of its brown pronotum.

Localities: Warmbaths, Pienaars River Rail, De Wildt (The Bushveld Basin). Five nest series.

Trinervitermes kurumanensis sp. n.

This species is exceptional because when viewed from above the clypeus appears to be bordered at either side with brown. This is due to the convexity of the clypeus, not to any inherent colour.

Locality: Kuruman, Bechuanaland, F. Thomsen, November 1916 one nest series; (six imagos). Mounds columnar 6 feet high.



Trinervitermes umzinduzii sp. n.

Imago remarkable for its small body.

Locality: Pietermaritzburg (Dr. E. Warren, one nest series, November 1918).

Trinervitermes pretoriensis sp. n.

Locality: Meukelneuk Hill, Pretoria, nesting under stones. Several nest series.

Trinervitermes abassas sp. n.

Locality: Abassas on Orange River, Namaqualand. Many imagos caught at lights (J. H. C. Kraphol, March 1921).

Trinervitermes thermarum sp. n.

Locality: Warmbaths (Bushveld Basin). Many imagos caught at lights. (Carl Rudolph, December 1916).

Genus SUBULITERMES Holmgren (1912).

According to Holmgren's classification there is but one nasutu caste in this genus and the nasuti differ from those of *Nasutitermes* (a) in exhibiting an aciculate nasum, (b) in having the dorsal profile of the head nearly straight, (c) in possessing workers the clypeus of which is always about as long as half its width, not much shorter as in *Nasutitermes*. The nasuti antennæ are cited as XII. jointed.

Only one African species has been recorded, *S. elegantulus* Sjostedt (1911) from the Cameroons and this is but doubtfully referred to *Subulitermes* by Holmgren (1912). This author also suggests that *Eutermes paucinervius* Silv. (1908), from the Kalahari, belongs to *Subulitermes*. Only the nasuti and workers are known of the first of these two species. The second is *Hamitermes paucinervius*.

We have in Bushmanland and Namaqualand a species of which no imagos have yet been obtained but of which the nasuti are so agreeable with the photo-engravers of *S. inaniformis* of the East Indies, that I have no hesitation in referring the local insect to *Subulitermes*; but the nasuti exhibit XIV. jointed antennæ and the clypeus of the worker is decidedly longer than half its width (7:10).

Subulitermes hainesi sp. n.

Nasutu:—Head chocolate brown, somewhat paler around mouth and antennal foveolæ; nasum black from base to about two-thirds of its length, from there to tip paler, suffused red brown. Legs and tergites pallid yellow. Cephalic margin of pronotum tinged with red brown. Head, from above, elongate turbinate; from the side, nasum longish, decidedly attenuate, dorsal profile straight, hind margin of antennal foveola before half the length of the head. Antennæ: XIV. jointed, joint III. narrow, not longer than II. Cephalic edge of pronotum entire and in a regular curve. Head, width 0.95 to 1.00; length 1.79 to 1.84; height 0.63.

Worker:—Head dark brown. Antennæ XV. jointed, joint III. shorter than II., quite narrow, the shortest joint; joint IV. a little wider than V. but of the same length; VI. longer than V. Cephalic edge of pronotum entire. Clypeus longer than half its width (7:10). Head width 1.10.

Localities: Steinkopf, Wolfdoon, Kenhardt. (F. Thomsen, J. C. Faure). This species constructs a low mound which is usually half buried by wind-blown sand.

Genus *TENUIROSTRITERMES* Holmgren (1912).

This genus was erected by Holmgren as a sub-genus for the reception of several North American species represented by nasuti of one caste with a dumb-bell shaped head, attenuated nasum, and the head profile longer in front of the depression than behind it. Further, the nasuti differ essentially from others herein mentioned in having a distinct apical spine upon the otherwise atrophied mandible. I have before me a nest series of a species that I can refer to no other genus than *Tenuirostritermes*.

Tenuirostritermes mallyi sp. n.

Imago:—Small, black and very glabrous, wings ample hyaline tinged with black. Head: quite black except for the white ocelli and small triangular fontanelle; clypeus black, antennæ black with pale and somewhat sordid rings. Tergites of thorax and abdomen black. Legs black except tips of tibiæ and tarsi which are yellow. Sternites of abdomen black, somewhat pallid in the middle. Conjunctiva creamy-white.

Head: flatly arched, without ridge connecting ocelli; fontanelle minute but easily discernible, triangular furcate. Clypeus inflated; faintly incurvate in front, rather curvate behind; as long or slightly longer than half its width (12 x 6 and 13 x 7). Eyes: black, subcircular. Ocelli: small, elongate oval, white, about twice their short diameter from eyes.

Antennæ: XV. jointed; joint III. shorter than II, joint IV. somewhat globose, larger and longer than V., longer and much wider than III.

Pronotum: almost semilunar, sides tapering to somewhat wide hind margin, as wide as the head across eyes, longer than half its width. (15:25). Meso- and metanotum: with broadly incurvate hind margins.

Wings: hyaline, fuliginous. C. and R. black. M. and Cu. weak but firmly defined; M. extending close to and parallel with Cu. and tending to supplant Cu., sending curved offsets to hind margin of the wing.

Headwidth across eyes 1.42; between 1.10. Body with head extended 9.5; body with wings 15; forewing with stump 12.5, without 12 x 3; span 25.5.

Nasutu:—Head dark chocolate brown, apical third of nasum pallid, reddish-yellow. Antennæ ochraceous. Thorax and abdominal tergites brown; coxæ and femora pale brown, tibiæ and tarsi pallid.

Nasum: acicular—Head: from above, elongate turbinate, plainly but not greatly constricted towards the base of the nasum; from the side, the straight profile of the nasum continues on to the vertex so that the arched hinder part of the head appears quite short. Nasum plainly longer than head-height; hind margin of antennal foveola at half the headlength. Mandibles with a very distinct conical spine situated towards their apex; when seen in a natural position, from the side, this spine appears to be two-fifths the length of the mandible.

Antennæ: XI, XII, and XIII. jointed; joint III. always almost twice the length of II. (9:5 or 8:5). When XI. jointed, IV. long and constricted, as long as I. (10:10); when XII., joint IV. a little longer than II. (6:5) and a little shorter than V. (6:7); when XIII., joint IV. a little shorter than II. (4:5) and plainly shorter than V. (4:6).

Pronotum: cephalic edge entire.

Head, width 0.89; length 1.58 to 1.62; height 0.57 to 0.63.

Workers:—Heads brownish, dorsal tergites paler grey brown: legs pallid; the bright white median line of the head is extended over thorax and abdomen, fading out more or less caudally. Clypeus half as long as wide. Cephalic edge of pronotum narrowly emarginate.

There are two worker castes differing but slightly in size. The larger have XV. jointed antennæ, the lesser, XIV. jointed antennæ. When XV., joint III. minute: V. smaller than IV., VI. globose; when XIV., joint III. is larger than II. and IV., obviously a compound (III. plus IV. of the XV. expression).

Locality: Malmesbury, Cape. (R. Birch, Oct. 1920). The series upon which this description is based was found living in a mound of *Hamitermes* sp.

Genus *COARCTATOTERMES* Holmgren (1912).

This genus was erected by Holmgren as a sub-genus for *nasuti* with dumb-bell shaped heads, or, as Sjöstedt more expressively puts it, with heads like a bird's skull, and thick cone-shaped noses; the clypeus of the worker not being quite as long as half its width. Three species were accorded to the sub-genus, two African and one from Madagascar. The African species were *coarctatus* and *bipartitus*, since then a fourth species, also African, has been described by Sjöstedt, this is known as *contractus*. The winged imagos are, I believe, here described for the first time and without doubt their characters are sufficient to give *Coarctatotermes* generic rank. Although I do not know *coarctatus* for the part of South Africa to which this paper is devoted, I have considered it desirable to include a description of the imago.

Coarctatotermes contractus Sjöst. (1913).

Imago: small, intensely black and glabrous with remarkably short wings. Head quite black; clypeus black-brown not contrasting with rest of head; joints I. and II. of the antennæ pale red-brown, the rest black with white rings. Tergites of thorax and abdomen black. Legs black except for the extreme tips of femora, the ends of the tibiæ and the whole of the tarsi which are yellow. Sternites of abdomen black except for a white median line broadening out on the anterior three. Conjunctiva pure white.

Head: connecting the ocelli a fairly distinct ridge interrupted in the middle at the fontanelle, behind this the vertex is plainly depressed; fontanelle minute but discernible and furcate. Clypeus: inflated, narrow and short (9×4) front margin faintly incurvate, hind margin flatly curvate. Eyes: black, oval. Ocelli: minute; sordid; deeply inset and three times their short diameter from eyes.

Antennæ: XIV. jointed, joint III. large, twice as long as II., and longer than IV.; always with a decided pseudo-articulation indicating a XV. expression in which joint III. would be minute and shorter than both II. and IV.

Pronotum: elongate semicircular, sides somewhat at right angles to front margin, not tapering, hind margin roundly curvate; longer than half its width (20×14). Meso- and metanotum: with angularly emarginate hind margins, that of the metanotum perhaps a little wider than the mesonotum; processes more or less triangular.

Wings: short, brownish, hyaline, when dry somewhat iridescent; C. and R. brown, more deeply coloured in basal half; with no streak below R.; M. and Cu. faint; M. runs close to and

parallel with Cu. and extends to the wingtip, with inferior straight branches or occasionally one or two superior branches in the apex of the wing. Between M. and Cu. the membrane of the wing is quite transparent.

Headwidth, across eyes 1·10; between 0·84. Body with head extended (males and females) 7 to 8; body with wings 10·5 to 11; forewings with stump 8·5 to 9·5; without 8 to 9 x 2·5; span 18 to 19·5.

Localities: De Wildt and Warmbaths, Transvaal; with major and minor nasuti and workers. I also have two nest series, each with a queen, from Bulawayo, collected by Dr. Arnold, found parabiologically with *Trinervitermes* sp. In the Transvaal, *contractus* has been found inhabiting the clay walls of the mounds of *Macrotermes natalensis* and *Trinervitermes fuscus*. The mound of one nest of *T. fuscus* at De Wildt was found to harbour, besides its original artificers, a colony each of *C. contractus*, *Cubitermes* sp. and *Eutermes* (*Microcerotermes*) sp.

Coarctatotermes coarctatus Sjöst. (1900).

Imago:—Colour as with *contractus*; head and body not so glabrous, clothed with sparse yellow setæ; only joint II. of the antennæ red-brown. Head: a more rounded ridge connects the ocelli than with *contractus* and there is no fontanelle opening. Otherwise as with *contractus*, except that the clypeus is longer than half its width (6:10).

Antennæ: very much as with *contractus* but joint III. relatively shorter and not exhibiting the tendency to sub-divide; XIV. jointed, joint III. a little longer than II., IV. as long as VI. and wider than both III. and V., joint V. as long as II.

Pronotum: quite different from that of *contractus*; sides curvate tapering to a narrow hind margin; longer than half its width (15 x 22). Meso- and metanotum: hind margins quite different from those of *contractus*, broadly incurvate.

Wings: similar to those of *contractus* but much longer and rather dark brown.

Headwidth, across eyes 1·21; between, 0·89. Body with head extended (males and females) 10 to 10·5; body with wings 12·5 to 13; forewing with stump 10·5 to 11·5 without 10 to 11 x 2·5; span 22 to 23·5.

Locality: Bulawayo, Rhodesia, collected by Dr. Arnold. This nest series was found at the same place as *contractus*, found parabiologically with *Trinervitermes* sp. As only minor nasuti and workers accompany the imagos, this, taken in conjunction with Sjöstedt's record, seems to point to the disappearance of the major nasuti in this species.

NASUTITERMES GROUP: SYNOPSIS OF SPECIES.

WINGED IMAGOS.

- I. Head and body intensely black and polished. Clypeus black or deep black-brown. Forewings relatively short, between 8 and 12 by 2·5 and 3 mm., somewhat Hyaline and without a subcostal streak. Legs black except tips of tibiae and tarsi, which are yellowish. Ocelli two to three diameters from eyes.
 - A. Fontanelle missing.

Wings brown; f.w. 10 to 11 x 2·5. H.W. 0·89. Antennæ XIV., III. a little longer than II. Pronotum with tapering sides. Meso- and meta. broadly incurvate.
Coarctatitermes contractus Sj.
 - AA. Fontanelle present.
 - b. Font. minute furcate, wings hyaline pallid rusty brown; f.w. short, 8 to 9 x 2·5. H.W. 0·84. Antennæ XIV., III twice as long as II. Sides of pronotum not tapering. Meso- and meta. angularly incised.
Coarctatitermes contractus Sj.
 - bb. Font. white, fairly large furcate-triangular. Wings hyaline fuliginous; f.w. 12 x 13. H.W. 1·0. Antennæ XV., III. shorter than II. Sides of pronotum tapering. Meso- and meta. broadly incurvate.
Tenuirostritermes mallyi sp. n.
- II. Head brown or castaneous; body never black, either brown, rust-brown, or yellowish. Clypeus yellow. Forewings relatively large, between 16·5 and 22 x 4 and 5·5. Legs pallid yellow or ochraceous. Ocelli from one-half to two-thirds of short diameter from eyes; (exception *T. abassas* one-sixth to one-third); Fontanelle large triangular-furcate. Posterior margin of pronotum variable in most species. Males a little smaller than females.
Trinervitermes spp.
 - A. Ventral sternites with dark areas around lateral pores. Wings opaque, fuliginous, with a yellow subcostal streak.
 - B. Pronotum a clear brown colour with a distinct moth mark. Posterior areas of meso. and meta. brown.

Clypeus yellow, F.W. of males, 16·5 to 16·7, of females 17·5 to 18. Antennæ XV., XVI., XVII. more frequently XV.; when XVI. and XVII. III. as long as II.
fuscus sp. n.
 - BB. Pronotum yellow, meso. and meta. concoloured therewith.
 - C. Clypeus apparently particoloured, margined on either side with dark brown so that it appears unusually narrow.

Meso. and meta. broadly incurvate meso. more deeply and widely than meta. and tending to be incised. F.W. 19·5 to 20·5. Antennæ XVI. and XVII., III. slightly longer than II.
kurumanensis sp. n.

CC. Clypeus not particoloured, yellow or ochraceous.

D. Genæ narrower below eyes than at articulations of mandibles; vertex of head somewhat flatly arched; meso. and meta. bilobed, meta. almost as deeply incised as meso.

e. Clypeus almost as long as half its width (19:40); front margin almost straight. Antennæ XVI. and XVII., usually XVI., III. plainly longer than II., (10:6). F.W. 19 to 21.

trinervoides Sj.

ee. Clypeus not almost as long as half its width, (17:41)); front margin flatly incurvate. Antennæ XV., XVI. and XVII., (86 % XVI.), when XVI. and XVII., III. a little longer than II. (10:8 or 10:7). F.W. 20 to 22. Meso. and meta. wider than with *trinervoides*. Pro. a somewhat bronzy yellow and darker in regions of anterior corners.

trinerviformis Holmg.

DD. Genæ as wide below eyes as at articulations of mandibles; vertex of head roundly arched; meso. and meta. broadly indented, processes flatly rounded; meta. shallowly indented.

e. Clypeus as long or longer than half its width. Meta. incurvate. Antennæ XV., XVI., XVII., usually XVI.; when XVI., III. shorter than II. (8:9); F.w. 19·7 to 21·5.

gemellus Sj.

ee. Clypeus not as long as half its width, Meta. incurvate or incised. Antennæ and wings as with *trinerviformis*; except that, in XVI. and XVII. expressions, III. may not be longer than II.

haviandii sp. n.

AA. Ventral sternites without brown patches around lateral pores. Tergites of abdomen yellow with brown patches around lateral pores. Forewings between 16 and 19. Span between 35 and 41·5. Wings various.

B. Genæ plainly constricted below eyes and distinctly narrower there than at articulations of mandibles.

Clypeus very short; not longer than one-third of its width; front margin deeply incurvate. H.W. 0·9 to 0·96, across eyes 1·37 to 1·39. Wings pallid yellowish without subcostal streak. F.W. 16 to 18 x 5. Antennæ XV., III. longer than II. (9:6). Meso. very shortly bilobed, meta. shallowly incised.

umzinduzii sp. n.

BB. Genæ not plainly constricted below eyes.

C. Meso. broadly incised, meta. bilobed and somewhat deeply incised.

Genæ slightly narrower below eyes than at articulations of mandibles. Clypeus short not almost as long as half its width (17:38). H.W. 1·12, across eyes 1:67. Wings yellow with

subcostal streak. F.W. 17 to 19 x 5. Antennæ XV. and XVI.; when XVI., III. longer than II. (8:5), V. coarse.

thermarum sp. n.

CC. Meso. and meta. somewhat truncate, posterior margins quite shallowly indented.

a. Genæ slightly narrowed below eyes. Clypeus shorter than half its width (16:36). H.W. 1.01 across eyes 1.58 to 1.60. Wings brownish, with faint sub-coastal streak. F.w. 18.5 to 19.5 x 5. Antennæ XV. and XVI.; when XV., III longer than II. (8:6); when XVI., III. as long as or shorter than II. Meso. shallowly incised, meta. broadly and shallowly incurvate.

pretoriensis sp. n.

aa. Genæ not narrower below eyes than at articulations of mandibles. Clypeus quite short, length a little more than one-third of width. H.W. 1.12, across eyes 1.59. Wings brownish, relatively narrow, with a very decided red-brown sub-costal streak. F.w. 16 to 16.5 x 4 to 4.5. Antennæ XVI. and XVII.; when XVI., III. as long as II. and V. coarse; when XVII., III. pseudo articulated and longer than II. (9:6) and V. short and narrow.

abassas sp. n.

NASUTI.

I. Head profoundly constricted, shaped like a bird's skull.

A. Head yellowish red, major and minor castes.

Coarctatotermes contractus Sj.

AA. Head black brown, minor caste only.

Coarctatotermes coarctatus Sj.

II. Head not profoundly constricted, more or less turbinate.

A. One soldier caste. Head chocolate brown; apical third of nasum pallid.

b. Dorsal profile straight to arched hinder part of head, mandibles plate-like with distinct apical spine.

Tenuirostritermes mallyi sp. n.

bb. Dorsal profile almost quite straight, mandibles plate-like without apical spine.

Subulitermes hainesi sp. n.

AA. Two or three soldier castes. Head reddish yellow, nasum black sometimes red-tipped. Dorsal profile incurvate. Mandibles plate-like without apical points.

Trinervitermes species.

B. Major nasutu with nasum plainly longer than head-height. Head elongate.

c. Nasum not tipped with red. When antennæ XIV. jointed, joint III. twice as long as II.

trinerviformis Holmg.

havilandi sp. n.

kurumanensis sp. n.

- cc. Nasum obscurely tipped with red. When antennæ XIV. jointed, joint III. as long as II. *fuscus* sp. n.
- BB. Major nasutu with nasum about as long as head-height. Head thick. Extreme tip of nasum more or less obscurely reddish.
- c. When antennæ XIV. jointed, joint III. longer than II. (6:4). *gemellus* Sj.
- BBB. Major nasutu with nasum shorter than headheight. Head thick and short. Antennæ XIII. jointed. Tip of nasum plainly reddish.
- c. Hind margin of antennal foveola before half the length of head. Headwidth 1.15. *umzinduzii* sp. n.
- cc. Hind margin of antennal foveola at half the length of head. Headwidth 1.21. *pretoriensis* sp. n.

VII. HAMITERMES GROUP.

Genus HAMITERMES.

No representatives of this genus have yet come to notice in that part of South Africa which is uninhabited by *Hodotermes* s. lat. The Southern region, as represented by the Cape Province, seems particularly rich in species and to favour the abundance of colonies. The further north one comes, the less frequently are nests of the genus found. From the collections before me, it would appear that each terrain supports two or three species. This is not reflected by those here treated because I have been compelled to withhold a number of species in the absence of imagos, deeming it most undesirable, as with *Trinervitermes*, to erect species upon the characters of soldiers.

As with *Trinervitermes*, so with *Hamitermes*, I have found so many characters common to the imagos or to the soldiers, that I have again contented myself with tabulating those differences that appear to me to be specific, introducing whenever possible qualifying soldier characters into the synopsis of the imagos. I have no reason to believe that any of the species under reference belong otherwise than to *Hamitermes* s. str. (sensu Holmgren).

The remarks made regarding the synopses submitted for the preceding group, hold good for the synopsis bearing upon this. It has only to be added that:

- (a). The "neck" of the soldier mandible is the part between the wide base and falcate blade.
- (b). The clypeus of the soldier is described as "long" when the length is approximately half the width, as "short" when the length is from one-third to one-quarter the width.
- (c). Of the species introduced into the synopsis those described by Silvestri (*paucinervius*, *seminotus* and *runconifer*.) have not come under my notice.

Hamitermes hastatus Hav. (1898).

This species is remarkable for the great difference in the size of the wings of the two sexes. The details given in the synopsis are drawn from an ample nest series collected at Zwartkops (1914) about seven miles from Port Elizabeth.

Hamitermes runconifer Sil. (1908).

This species is reported from Kooa-Sekgoma in the Kalahari (Nov. 1904). I have not been able to reconcile any of the material before me with Silvestri's species and this leads me to gravely doubt Holmgren's Zululand record (1913), more especially as soldiers I possess from the same and neighbouring terrains are quite unrelated to either *hastatus* or *runconifer*.

Hamitermes seminotus (Silv.).

= *Eutermes* (s. lat.) *seminotus* Silv. (1908).

Although I have been unable to secure material of this Kalahari (Kooa) species, I have no hesitation in regarding *seminotus* as belonging to *Hamitermes*.

Hamitermes paucinervius (Silv.).

= *Eutermes* (s. lat.) *paucinervius* Silv. (1908).

= ? *Subulitermes paucinervius* Holmg. (1912).

This Kalahari (Khakhea) species also belongs to *Hamitermes*, not to *Subulitermes* as suggested by Holmgren.

Hamitermes gunni sp. n.

This species seems to be abundant in the neighbourhood of Bathurst. Criteria from a number of nest series from Trappes Valley, Clumber, Bathurst (D. Gunn, February 1917; F. Thomsen July 1917).

Hamitermes londonensis sp. n.

Three imagos, soldiers and workers from East London (E. Impey, June 1920).

Hamitermes zuurbergi sp. n.

Criteria from an ample nest series obtained at Zuurberg, (Somerset East) (J. Hewitt, January 1917).

Hamitermes kellyi sp. n.

Two nest series from Grahamstown (A. E. Kelly, February 1915).

Hamitermes capicola Silv.

= *Hamitermes hestatus* var. *capicola* Silv. (1914).

The type locality is Stellenbosch. The criteria given in the synopsis is from an ample nest series obtained at Stellenbosch (Dr. Hans Brauns, March 1920) which shows *capicola* quite distinct from *hastatus*.

Hamitermes schoombiensis sp. n.

An ample nest series from Schoombie, (Middleburg Dist.) (F. Thomsen, Feb. 1915).

Hamitermes libertatis sp. n.

Large series of imagos with soldiers, Bloemfontein, Orange Free State, (J. C. Faure, February 1915).

Hamitermes limpopoensis sp. n.

Four imagos, many soldiers. Nest in the dead limb of a tree at confluence of Zand and Limpopo Rivers, Northern Transvaal; (Nov. 1916).

Hamitermes atlanticus sp. n.

Two nest series, Table Mountain and Camps Bay, near Cape-town. (R. Birch, June 1920).

Hamitermes braunsi sp. n.

One nest series imagos accompanied by one soldier. Willowmore. (Dr. Hans Brauns, March 1920).

Hamitermes bechuana sp. n.

One nest series imagos and workers, Greefdale, Barkly West, (F. Thomsen, February 1916).

Hamitermes murraysburgi sp. n.

Series of imagos and workers Murraysburg, Cape Province: (R. Helm, Feb. 1918).

Hamitermes kenhardtii sp. n.

Large series of imagos and workers Kenhardt District, Cape Province (J. C. Faure, March 1917).

Hamitermes messinae sp. n.

One imago, one soldier with workers, found by the writer in turret of *Termes* (O), *latricius* at Messina, Northern Transvaal. (November 1916).

SYNOPSIS OF SPECIES.

HAMITERMES.

- I. Pronotum with front margin shortly but plainly produced, produced part roundly emarginate (see also CCCC, *dd.*)
H. messinae sp. n.
- II. Pronotum with front margin straight, not produced.
 - A. Females exceptionally larger than males; f.w. of female 11.5 to 12 × 3 mm., of male 9 to 9.5 × 2.5 mm. [See also EE and CC, D, e].
H. hastatus (Hav)
 - B. Females not strikingly larger than males. [Except the sexes of *H. hastatus*, as hereunder introduced.]
 - C. Forewings between 10 and 12.5 × 3 mm.
 - D. Clypeus plainly paler than head, yellow. Head longer than wide.

- E. Pronotum somewhat trapezoidal, anterior corners broadly rounded, sides faintly incurvate, hindmargin half the length of front margin and either straight or faintly incurvate. Pron. always longer than half its width and wider than head between the eyes.
- f.* Meta. bilobed and rather deeply incised, processes rounded; meso. flatly incurvate. *Soldier*: Clypeus short, grooved, margin broadly incurvate. Mandibles with short necks and pointed, somewhat introse teeth.
- H. gunni* sp. n.
- ff.* Meso. and meta. both broadly incised, meta. the more broadly and deeply. *Soldier*: Clypeus short, grooved, margin incurvate. Mandibles with short necks, teeth pointed and retrose.
- H. londonensis* sp. n.
- fff.* Meso. and meta. both incurvate, processes short, blunt; incurvature of meso. deeper and wider than that of meta. Meta. of male more narrowly and shallowly incurvate than that of female. *Soldier*: Clypeus short, grooved, broadly incised. Mandibles with long necks and retrose teeth.
- H. zuurbergi* sp. n.
- ffff.* Meso. and meta. both broadly incurvate; meso. more deeply and widely than meta. *Soldier*: Clypeus short, plainly bilobed. Mandibles with long necks, teeth retrose.
- H. kellyi* sp. n.
- EE. Pronotum not trapezoidal, sides somewhat curve, hindmargin slightly incised, corners not broadly rounded. Meso. rather deeply incurvate, meta. rather broadly and deeply incised. *Soldier*: Clypeus short, grooved and somewhat truncate. Mandibles with short necks, teeth somewhat introse and points obliquely truncate.
- H. capicola* Silv.
- DD. Clypeus wholly or partly castaneous, almost as dark as head.
- F. Head longer than wide, anterior corners of pron. broadly rounded.
- g.* Clypeus wholly castaneous, Meso. broadly incised, meta. somewhat bilobed, less widely and more deeply incised than meso. *Soldier*: Clypeus long, bilobed, deeply cleft. Mandibles with short necks, teeth somewhat introse and acute.
- H. schoombiensis* sp. n.

gg. Clypeus particoloured somewhat yellowish posteriorly in the middle. Meso. and meta. broadly incised, meta. more narrowly and deeply than meso.

Soldier: Clypeus short, broadly grooved. Mandibles with long necks; teeth retrose, that of left more acute; blades with in-bent apical points.

H. libertatis sp. n.

FF. Head as wide as long; anterior corners of pro. somewhat acutely rounded.

Clypeus wholly castaneous; eyes very large. Meso. and meta. with straight and sharply tapering sides, both narrowly and acutely incised; notch of meso. larger than that of meta., (3:2). H.W. 0.95 to 1.00.

Soldier: Clypeus short, grooved.

Mandibles with long necks, teeth acute and retrose.

H. hastatus (female)

CC. Forewings between 9 and 9.5×2.3 and 3 mm.

D. Pronotum with curvate sides.

E. Head not longer than wide. Pro. as long as half its width. Font. fusiform. Meso. and meta. acutely and narrowly incised, as with females. H.W. 0.79. Wings $\times 2.5$.

H. hastatus (male)

EE. Head longer than wide. Pro. longer than half its width.

f. Pro. slightly longer than half its width. Font. minute circular. Meso. and meta. as with *H. hastatus*, male. H.W. 0.57. Wings $\times 2.3$.

Soldier: Unknown.

[According to Silvestri]

H. paucinervius Silv.

ff. Pro. plainly longer than wide. Font. turbinate. Meso. and meta. with broadly curvate sides, posterior margins narrowly incurvate, Meta. more deeply than meso. Wings $\times 3$; venation somewhat as with *paucinervius*.

Soldier: Clypeus short, bilobed, broadly cleft.

Mandibles with short necks; teeth introse, tips slightly upbent, that of left obliquely truncate.

H. limpopoensis sp. n.

DD. Pronotum sub-trapezoidal; sides straight or very faintly incurved; a little longer than half the width.

E. Head not longer than wide.

f. Font. oval, rather large. Meso. and meta. broadly incurved, meta. less incurvate than meso. H.W. 0.92.

Soldier: Unknown.

[According to Silvestri]

H. seminotus Silv.

- ff.* Font. furcate, represented by an elongate narrow Y-shaped stripe. Meso. and meta. as with *seminotus*. Wing venation as figured for *paucinervius*.

H. atlanticus sp. n.

EE. Head longer than wide.

- f.* Font. small, oval. Meso. and meta. somewhat equally and broadly incurvate. H. W. 0.92.

Soldier: Clypeus bilobed,

Mandibles with short neck and retrose teeth.

[According to Silvestri]

H. runconifer Silv.

- ff.* Font. large oval to broadly fusiform. Meso. and meta. as with *runconifer*. Pro. rather long.

Soldier: Clypeus short, bilobed.

Mandibles with introse teeth. That of right with parallel sides and truncate tip, that of left with upper edge at a right angle with the blade lower edge slanting to neck.

H. braunsi sp. n.

- fff.* Font. minute circular (as in *paucinervius*). Meso. and meta. as in *paucinervius*. Wing venation brown, moderately well defined, not as with *paucinervius*. H.W. 0.74.

H. bechuana sp. n.

CCC. Forewings 8.5×2.5 .

Pronotum short, not wider than head between eyes. Head as long as wide. Font. oval, clearly defined. Meso. broadly incurved, meta. rather deeply incised.

Soldier: Unknown.

H. murraysburgi sp. n.

CCCC. Forewings between 7.2 and 7.7×1.7 and 2 . Head longer than wide, Pro. not wider than head between eyes.

- d.* Pronotum sub-trapezoidal. Font. elongate oval. H.W. 0.84, F.w. 7.7×2 . Meso. and meta. both rather deeply incurvate, meta. rather roundly incurvate.

Soldier: Unknown.

H. kenhardti sp. n.

- dd.* Pronotum with front margin produced, hind-margin plainly incurvate, sides rounded.

Font. white, represented by a tadpole shaped mark. Meso and meta. shallowly incurvate, meta. more narrowly incurvate than meso. F.w. 7.2×1.7 ; venation well defined, veins rather black, Cu. with sub-dividing branches

Soldier: Labrum shorter than wide, semi-lunar. Clypeus short, bilobed, broadly cleft.

Mandibles fine, with long necks and acute retrose teeth. Cephalic edge of pronotum plainly crenate.

H. messinae sp. n.

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(To be continued)

Reviews.

The Natural History of South Africa. By F. W. Fitzsimons, F.Z.S., F.R.M.S., Director, Port Elizabeth Museum. Mammals, in Four Volumes. (Longmans, Green & Co., London).

Volumes I. and II. were published in 1919 and Volumes III. and IV. in 1921. Volume I. deals with the Primates, the Chiroptera and the Carnivora in part (the cats proper). Volume II., with the Civets, Genets, members of the mongoose family, dogs, jackhals, the Mustelidæ and the sea lion. Volumes III. and IV., with Ungulates, the rodents and the whales.

Although only short descriptions of the animals are given, their habits are very fully dealt with and numerous anecdotes are related that should appeal to the layman. The work is well printed, conveniently arranged and thoroughly illustrated. It is one that has long been wanted and is greatly to be commended, especially as an introduction to a more serious study of our fauna. However, many of the illustrations are vastly disappointing. These have been prepared from photographs of museum specimens and the titles imply that they depict the living animals in their natural surroundings. This cannot be too strongly disapproved of. Unhappily some of the pictures are grotesque either because the specimens portrayed are so obviously stuffed or because they were set down for portraiture in the wrong surroundings. (*Contributed*).

South African Mammals. By Alwin Haagner, Director of the National Zoological Gardens of South Africa. H. F. & G. Witherby, London, and T. Maskew Miller, Cape Town. 1920. Price 20s. net.

This well-printed book serves as an introduction to the study of South African Mammals, and will be found useful and in-

teresting to students, sportsmen, travellers and amateur naturalists. It makes a direct appeal to all lovers of animals.

The subject-matter deals with the various orders of Mammals, from the Primates to the Edentates, a chapter being devoted to each of the twelve orders considered in the 248 pages comprised in the volume. Of these over 100 pages are devoted to the Ungulata, wherein rather more than half relate to the various antelopes, and hence are of special interest to the genuine sportsman. There are no less than 141 exquisite illustrations, many of them photographs from life, especially of animals living in the National Zoological Gardens, Pretoria, or in the field.

A very useful mode of treatment has been adopted.

A short account of each order, family and genus, having representatives in South Africa, is given in its appropriate place. Each species of animal discussed is described under its scientific, common English, common Dutch and various native names, a feature of great service to the traveller. The general appearance, size, relative abundance and geographical distribution are discussed in each case, while graphic and lucid descriptions are given as to the homes, haunts and habits of the various animals.

The author also deals with the economic importance of some of the animals described. He clearly sets forth the aesthetic value of the indigenous South African fauna, and protests against wanton and indiscriminate slaughter merely for domestic purposes or for thoughtless financial gain. He urges, and rightly, that farmers and land owners should "realise the important fact that the game is not merely their property, but that it is an asset to the country and belongs quite as much to their heirs and successors."

The author is to be congratulated on his work, and we hope that the volume will have a wide sale, especially in South Africa.

H. B. F.

CATALOGUE OF BOOKS IN LIBRARY OF THE
SOUTH AFRICAN BIOLOGICAL SOCIETY.

BIRDS.

- Catalogue of Canadian Birds. Macoun.
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PRACTICAL ZOOLOGY

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Professor of Zoology in the University of Cape Town.

AND
C. von BONDE, M.A.
Lecturer in Zoology in the University of Cape Town.

PREFACE

THIS book is intended for Students of Elementary Zoology. The part dealing with the Frog and the Platana or Clawed Toad has been in use for some time at Cape Town University, and has proved so valuable an aid to the work in the practical classes that other types have now been added in this new and enlarged edition.

Being specially adapted for the requirements of students in South Africa, the book contains descriptions of certain South African types which are not dealt with in other practical manuals; and, at the suggestion of the publishers, in order to make the work useful for other students, the principal European types, which are sometimes used in South Africa, have also been described.

It is recommended that the Frog be studied first, as it is particularly suitable for an introduction to the subject. The other types may be taken in any order convenient.

The instructions given throughout the text will be clearly understood by reference to the numerous figures. The figures are not to be copied by the student. A drawing of the actual dissection is to be made on the blank page provided; and the student should be prepared to point out the various parts to the teacher.

The instructions can be followed without preliminary lectures, and are designed for the use of medical students and others whose course in General Zoology may be mainly restricted by the inclusion of anatomical details. A short lecture course is often overburdened with these details, which, we think, can much better be given in the form of a practical handbook.

With a few exceptions, the figures are original and have been drawn from actual dissections.

The publishers particularly desire to express their thanks to Mr. Robert A. Staig (formerly Demonstrator of Zoology) School of Medicine of the Royal Colleges, Edinburgh, and University of Glasgow, for the continual assistance of his advice in the preparation of this publication for the press, and for the excellence of his work in reading the proofs and compiling the index.

J. D. F. G.
C. v. B.

ZOOLOGICAL LABORATORY,
UNIVERSITY OF CAPE TOWN,
1922.

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